THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Established in 1962

Edited by WILLIAM HOVANITZ

Volume 9

1970

published by
The Lepidoptera Research Foundation, Inc.
at
1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

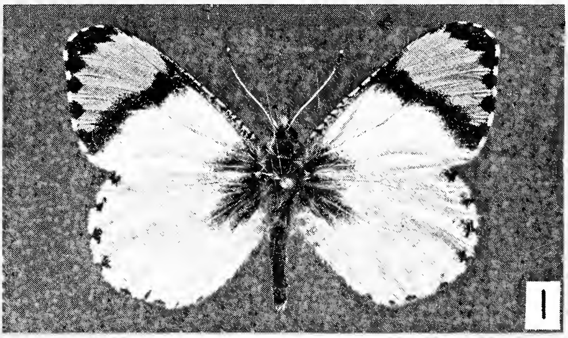
CONTENTS

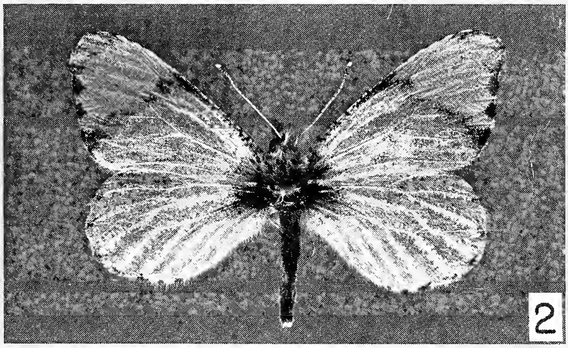
Volume 9 Number 1 March, 1970

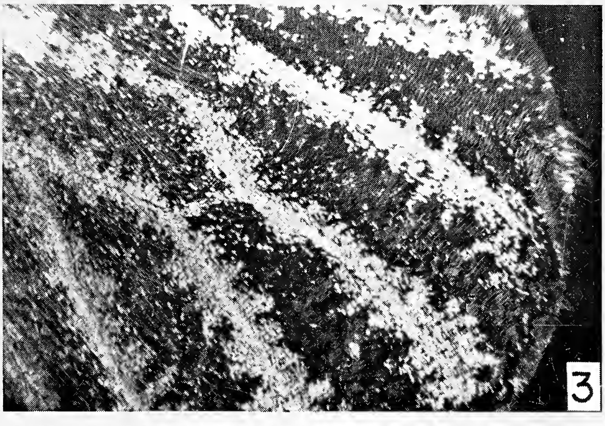
Volume 9 Number 2 June, 1970

7/21

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA







Volume 9 Number 1 March, 1970

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 9(1):1-9, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

SPRING MOTH ACTIVITY IN RELATION TO LOCALITY, TEMPERATURE AND AIR PRESSURE

CHARLES L. SELMAN and HARVEY E. BARTON[1]

Division of Biological Sciences,
Arkansas State University,
State University, Arkansas 72467

INTRODUCTION

THIS PAPER SUMMARIZES THE RESULTS of studies conducted with blacklight traps in Fulton County and Craighead County, Arknsas, on four species of moths which are active during the first one-third of the year, 1970. Three of these moths are noctuids: *Eupsilia sidus* (Guenee), *Taeniocampa garmani* (Grote), and *Phoberia atomaris* (Hubner). The fourth is a geometrid: *Hyrdiomena mississippiensis* (McDunnough). These moths began appearing very early in the year, and by May 1, 1970, their activity appeared to be at an end. Records were kept on the number of moths trapped, the daily high temperatures, daily mean temperatures, and atmospheric pressure. The purpose of this study was to relate weather conditions to activity patterns and to compare these factors in two dissimilar counties.

Blacklight lamp traps are useful in insect research and surveys. They can be used to determine the periods of greatest activity, the distribution, and seasonal abundance of a number of insect species (Comstock, 1879; Hollingsworth, 1963; King, 1960). Recently work has been done on measuring the efficiency of light trap catches in relation to total populations (Falcon, 1967; Hartstack *et al*., 1968; Stewart *et al.*, 1968). Falcon (1967) noted good correlation between the field counts of bollworm eggs and larvae and the mean number of moths collected in the light traps. However, Hartstack *et al.*, (1968) established that efficiency of blacklight traps varied with the species of insect. Stewart *et al.*, (1968) noted that various species were trapped more efficiently at different heights.

[1]*This research was supported in part by Arkansas State University Research Grant #511-654.*

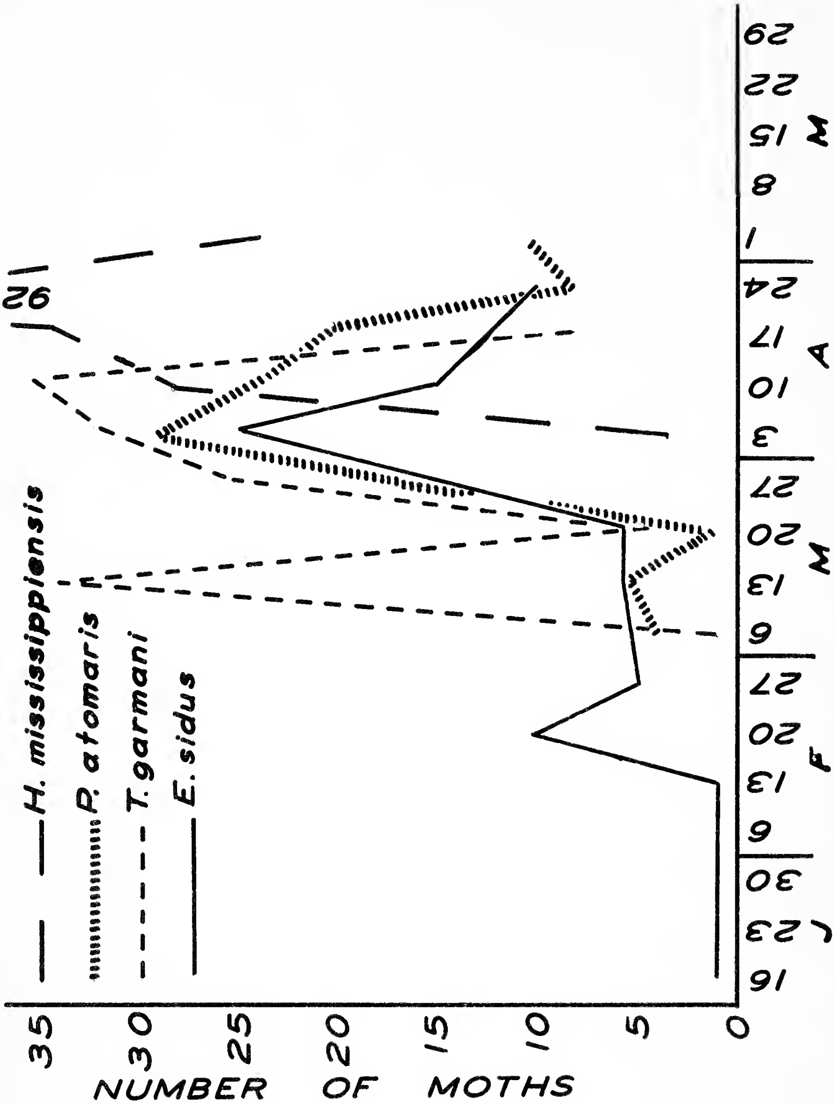

H. mississippiensis
P. atomaris
T. garmani
E. sidus
NUMBER OF MOTHS
0
5
10
15
20
25
30
35
92
TRAP INTERVAL ENDING
J
16
23
30
F
6
13
20
27
M
6
13
20
27
A
3
10
17
24
M
1
8
15
22
29

Fig. 1

Studies have been made on the effects of temperature and other weather factors in relation to insect activity, population, and emergence (King, 1962, 1966; Williams, 1939, 1940). Williams (1940) studied activity effects, while King (1962) demonstrated a relationship between emergence and rainfall.

METHODS AND MATERIALS

Two traps were utilized in this study, each equipped with omnidirectional, 15-watt blacklight lamps. The traps were modified from Falcon (1967) by using a one-gallon jar containing 70 percent isopropyl alcohol for collecting the moths. The traps were emptied daily.

One trap was located three miles south-west of Mammoth Spring, in Fulton County, Arkansas, which is in the Ozark Highlands. The area is primarily oak-hickory forest. The small percentage of land which is cleared is largely in pasture. The second trap was located approximately eighty miles south-east of Mammoth Spring, four miles north-east of Jonesboro in Craighead County, Arkansas. Craighead County is in the Mississippi alluvial plain, and the greatest percentage of the land is in tillage.

Climatological data for the Jonesboro trap was obtained from Federal Aviation Administration records at Jonesboro, Arkansas, and was recorded approximately three miles from the trap. Weather information for the Fulton County trap was obtained from Radio Station KALM where weather is recorded daily. The radio station is located approximately five miles north-west of the Fulton County trap.

RESULTS

T. garmani — A total of 269 specimens was taken from both traps. Only nine of these were taken in Craighead County. They first appeared in both the Fulton County and the Craighead County traps during the week of March 6 (Fig. 1). Activity was at its greatest from March 8 to April 11. Population peaks occurred when the daily mean temperature reached 50°F. (Fig. 3). This seems to indicate that the optimum temperature for *T. garmani* activity is 50°F. The only peak reached on the daily high temperature was 72°F. (Fig. 2). It is interesting that large numbers were continually trapped in Fulton County at atmospheric pressures over 29.95 inches (Fig. 4). This was not the case with the other moths under consideration .

P. atomaris — A total of 135 specimens was taken from both traps. Only four were taken in Craighead County. The first

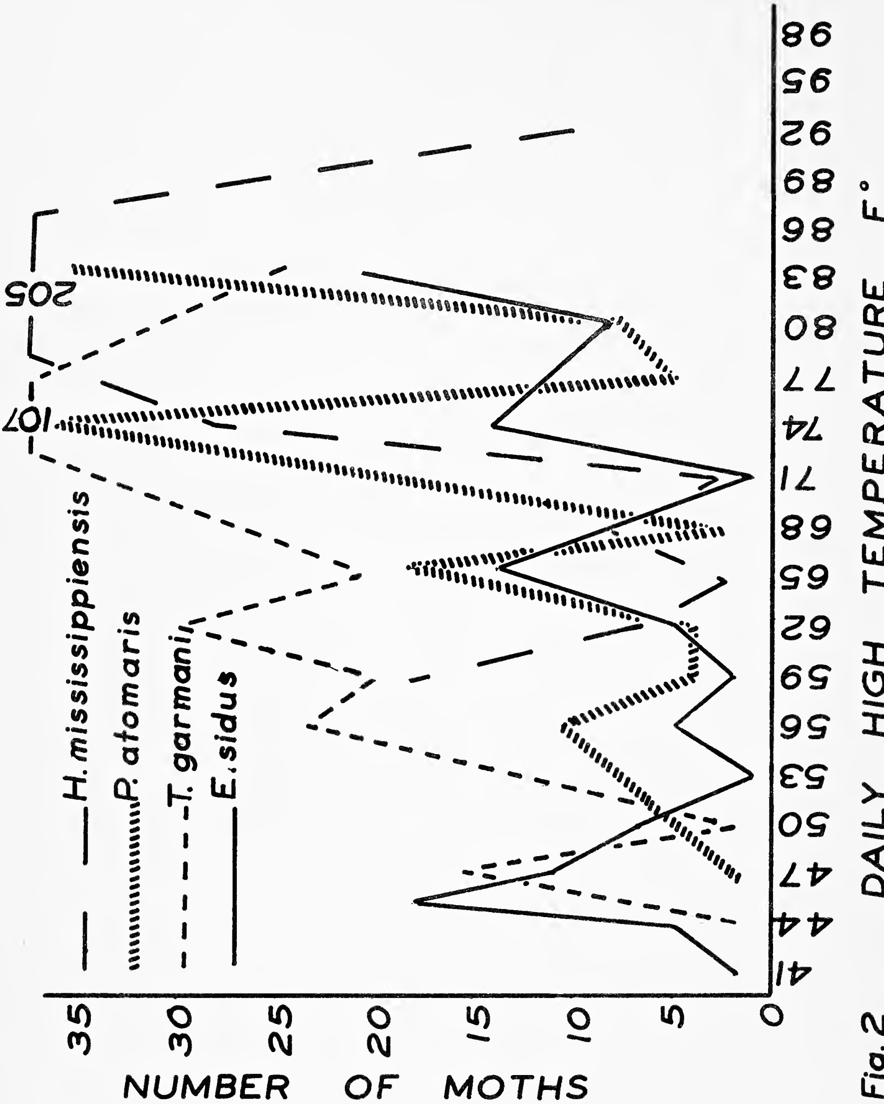

H. mississippiensis
P. atomaris
T. garmani
E. sidus
205
107
98 95 92 89 86 83 80 77 74 71 68 65 62 59 56 53 50 47 44 41
DAILY HIGH TEMPERATURE F°
35 30 25 20 15 10 5 0
NUMBER OF MOTHS

Fig. 2

specimens taken in Fulton County came to the trap during the interval beginning March 3 (Fig. 1). A peak was reached during the first week in April and activity ceased on April 29. The greatest number was trapped on April 5. The daily mean temperature showed peaks at 52°F. and 67°F., with a lesser peak at 43°F. (Fig. 3). Activity increased when the daily high temperature was above 72°F. (Fig. 2). Larger numbers of this moth were consistently taken when the atmospheric pressure was 30.20 inches (Fig. 4). Activity dropped off as pressure deviated either side of 30.20 inches.

H. mississippiensis — A total of 321 specimens was taken from both traps. Only sixteen were taken in Craighead County. The first specimen appeared at the Fulton County trap on March 31, and the last one was trapped on April 30 (Fig. 1). The activity reached its height during the third week of April. Catches prior to and following this week were not large (Fig. 1). The daily mean temperature at which the greatest number of these moths was trapped was between 66°F. and 70°F. (Fig. 3). This would suggest an optimum temperature of 68°F. for this moth. When the daily high temperature reached 82°F. moth activity increased (Fig. 2). Again, activity greatly increased when the atmospheric pressure reached 30.20 inches, and activity dropped off with any deviation either side of 30.20 inches (Fig. 4).

E. sidus — A total of 101 specimens was taken from the Fulton County trap alone. None appeared in Craighead County. The first specimen appeared on January 16, while the last one taken appeared on April 24 (Fig. 1). The number of these moths steadily increased until a peak was reached on April 3. The data obtained for the daily high temperature (Fig. 2) and the daily mean temperature (Fig. 3) revealed no correlation to numbers of moths caught. Again, atmospheric pressure was of interest. Like *P. atomaris* and *H. mississippiensis*, the activity of *E. sidus* greatly increased as atmospheric pressure approached 30.20 inches (Fig. 4). It should be noted that if this curve were plotted by using Forbes' (1953) equation, it would indicate a peak at somewhere between 30.15 and 30.20.

CONCLUSIONS AND DISCUSSION

All four moths were found in greater numbers in Fulton County than in Craighead County. This could be attributed to the contrasting topographies of the two counties, the possibility that higher temperatures in Craighead County are less favorable to these moths, the feeding preferences of these moths, or a combi-

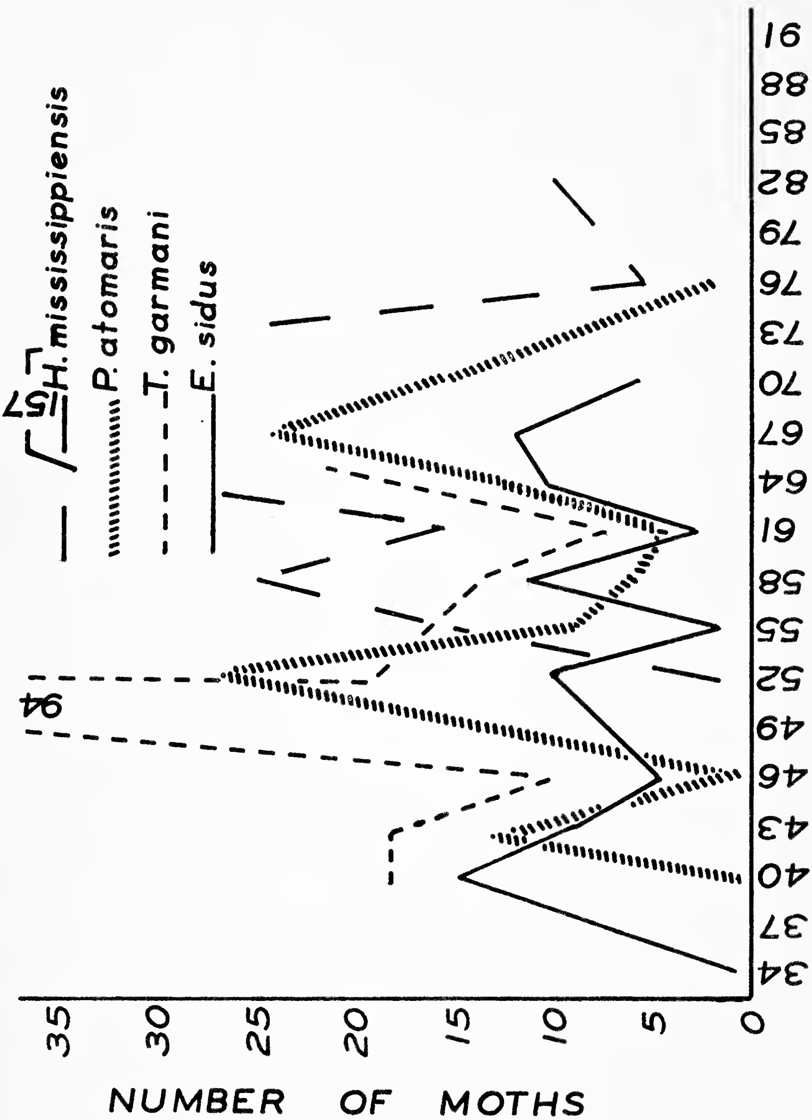

157
H. mississippiensis
P. atomaris
T. garmani
E. sidus
94
NUMBER OF MOTHS
35
30
25
20
15
10
5
0
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
DAILY MEAN TEMPERATURE F°

Fig. 3

nation of these factors. All four species had sharply defined population peaks (Fig. 1). *T. garmani* showed two peaks approximately one month apart.

No correlation could be made between daily high temperature and numbers of *E. sidus* and *P. atomaris* (Fig. 2). However, *H. mississippiensis* increased activity each evening after the daily high temperature reached 82°F. This was to be expected since, generally, moth activity increases at higher temperatures. *E. sidus* did not seem to be affected by variations in tempearture.

The daily mean temperature for *P. atomaris* gave no trend (Fig. 3). *H. mississippiensis,* however, did indicate a possible optimum tempertaure of between 66°F. and 70°F. *T. garmani* showed a sharp peak at a daily mean temperature of 50°F. This also was consistent because activity immediately dropped off with any deviation from this 50°F. mean temperature.

Our most interesting data were obtained from atmospheric pressure (Fig. 4). *P. atomaris, E. sidus,* and *H. mississippiensis* indicated a definite trend in that their activity was always at its greatest around 30.20 inches of atmospheric pressure. Any time the atmospheric pressure deviated from this point, there was a sharp decline in the activity of these three moths. *T. garmani* was an exception to this in that it consistently appeared at pressures over 29.95 inches.

ACKNOWLEDGEMENTS

We would like to express our appreciation for the help in the maintaining of the traps to Dr. Richard Mitchell of Arkansas State University and to Wilbur Mitchner of Mammoth Spring, Arkansas. We are also indebted to Richard Heitzman of Independence, Missouri for his constant help in the identification of our Lepidoptera and for his critical reading of the manuscript.

REFERENCES CITED

COMSTOCK, J. H. 1879. Fires, trap-lanterns, etc. *USDA Div. Entomol.,* Washington, D.C. In Report upon cotton insects. pp. 262-75.

FALCON, L. A., W. R. BAUER, G. T. OKUMURA, V. E. BURTON, R. VAN DEN BOSCH, and G. TRACT. 1967. Light traps and moth identification—an aid for detecting insect outbreaks. *Univ. Calif. Agr. Sta. and Ext. Serv. Leaflet* 197.

FORBES, W. T. M. 1953. Note on multimodal curves. *Ann. Entomol. Soc. Amer.* 46: pp. 221-4.

HARTSTACK, JR., A. W., J. P. HOLLINGSWORTH, and D. A. LINDQUIST. 1968. A technique for measuring trapping efficiency of electric insect traps *Jour. Econ. Entomol.* 61(2): pp. 546-552.

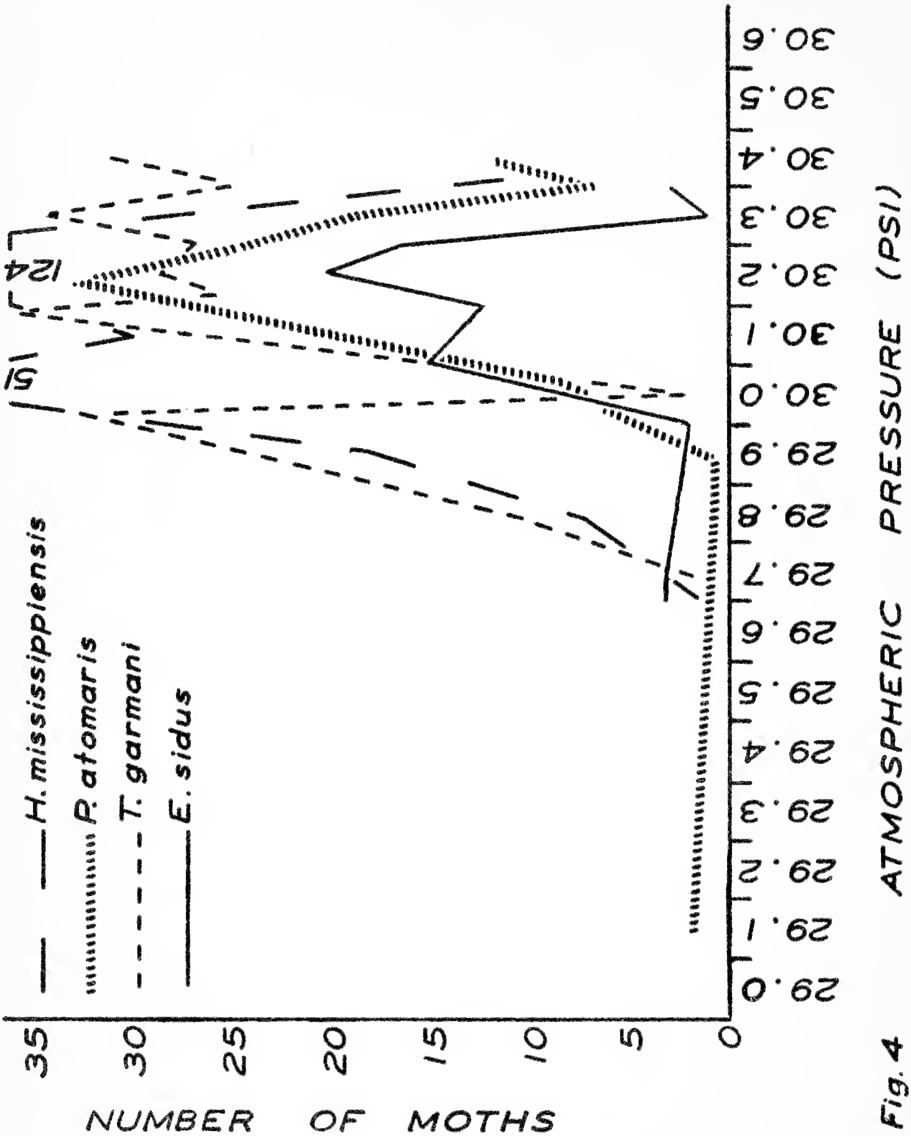

H. mississippiensis
P. atomaris
T. garmani
E. sidus
124
151
35
30
25
20
15
10
5
0
NUMBER OF MOTHS
29.0
29.1
29.2
29.3
29.4
29.5
29.6
29.7
29.8
29.9
30.0
30.1
30.2
30.3
30.4
30.5
30.6
ATMOSPHERIC PRESSURE (PSI)

Fig. 4

HOLLINGSWORTH, J. P., J. G. HARTSOCK, and J. M. STANLEY. 1963. Electric insect traps for survey purposes. *ARS* 42-3-1. 10 pp.

KING, E. W. and A. T. HIND, 1960. Activity and abundance in insect trap sampling. *Ann. Entomol. Soc. Amer.* 53(4): pp. 524-9.

KING, E. W. 1966. Rainfall, temperature, and population levels of certain South Carolina lepidoptera. I. *Trichoplusia ni. Ann. Entomol. Soc. Amer.* 59: pp. 1049-52.

————. 1962. The use of weather in the estimation of field populations of insects. *South Carolina Agric. Exp. Sta. Tech. Bull.* 1008. 25 pp.

STEWART, PAUL A., C. R. GENTRY, C. M. KNOTT, and J. J. LAM, JR. 1968. Seasonal trends in catches of moths of the tobacco hornworm, tomato hornworm, and corn earworm in traps equipped with blacklight lamps in North Carolina. *Jour. Econ. Entomol.* 61(1): pp. 43-46.

WILLIAMS, C. B. 1939. An analysis for four years' captures of insects in a light trap. Part I. *Trans. Roy. Entomol. Soc. London.* 89: pp. 79-132.

————. 1940. An analysis of four years' captures of insects in a light trap. *Ibid.* 90: pp. 227-306.

REVIEW

The Moths of America North of Mexico. Fascicle 21. Sphingoidea. Ronald W. Hodges. 1971. 158 pages, 14 color plates, notes, etc. V-XII.

E. W. Classey Limited and R. B. D. Publications Inc. London.

U. S. A. distributor: Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, California 90007. $24.00 (Subscription price: $19.60).

This is the first fascicle of a work intended to cover all the moths of the northern part of North America, including Greenland. The format is well set out, 6½ x 9 inches, and extremely well done. The 14 color plates are well printed from color photos by lithography in four colors. The entire work, from the paper used, to printing and color rendition, is expected to be of superb quality.

The handling of the species in the first fascicle is that of the standard taxonomic arrangement: Synonomy, description, general comments and known geographical distribution.

From a biological and personal standpoint, the reviewer would like to see changes made in future issues along these lines: (1) The biological relationship of the "species" to one another discussed, or analyzed, (2) Maps of the complete distributional ranges indicated (3) The genetic relationships of the taxonomic units to one another indicated (That is, complete or only partial genetic isolation), (4) The ecological niche occupied by each taxonomic category. In addition, despite the sharp detailed rendition of the moths on the plates, the great attempt to eliminate shadows has seriously created a very "flat" appearance. In the reviewers' experience, the scales on the Lepidoptera wing must reflect light to give a natural impression and this cannot be done by lighting the subject from all directions.

Despite these personal opinions of the reviewer, the work must be considered of immense importance of American literature—it replaces nothing and fills a tremendous gap. It will not be replaced for years, if generations, to come. All libraries and individuals interested in Lepidoptera must have it for reference and daily use.

W. Hovanitz

Journal of Research on the Lepidoptera 9(1):11-16, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

ECOLOGICAL AND DISTRIBUTIONAL NOTES ON *EREBIA DISCOIDALIS* (SATYRIDAE) IN THE NORTH CENTRAL STATES

JOHN H. MASTERS[1]

P. O. Box 7511, Saint Paul, Minnesota

EREBIA DISCOIDALIS Kirby is one of the most wide-spread *Erebias* in North America, occurring from Alaska to Churchill, Manitoba and then southward, principally in bogs, to Northcentral Minnesota and Wisconsin and Central Ontario. However, its range has been poorly documented and prior to 1964 only four specimens had been recorded from the United States: Elder (1961) took three specimens over a three year period (1929-1930) in Forest County, Wisconsin and Daggy (1936) took a single specimen from Clearwater County, Minnesota on 31 May 1935. Huber (1965) rediscovered the species in Minnesota (Lake County, 24 May 1964) and in the six years since then it has been consistently taken in Minnesota, rediscovered in Wisconsin and first recorded for Michigan and North Dakota.

I found *Erebia discoidalis* to be quite widespread, although uncommon and intensely local, in the Canadian Zones of these states. It was, for the most part, restricted to sphagnum bogs. It seems unlikely to me that the species has extended its range in recent years. A more likely explanation for the paucity of records in the past is that it has simply been overlooked by collectors as a result of a combintion of an early season flight period, the habitat preference for bogs and a habit of preferring to fly either quite early or very late in the day.

Unlike *Erebia disa* (Thunberg) which is found in bogs containing dense stands of spruce (Masters, 1969), *E. discoidalis* seems to prefer bogs with large open areas, lots of grass and only a few trees, however they are usually encountered near the edges of these bogs or in close proximity to trees except during the

[1]Research Associate, Carnegie Museum, Pittsburgh, Pennsylvania.

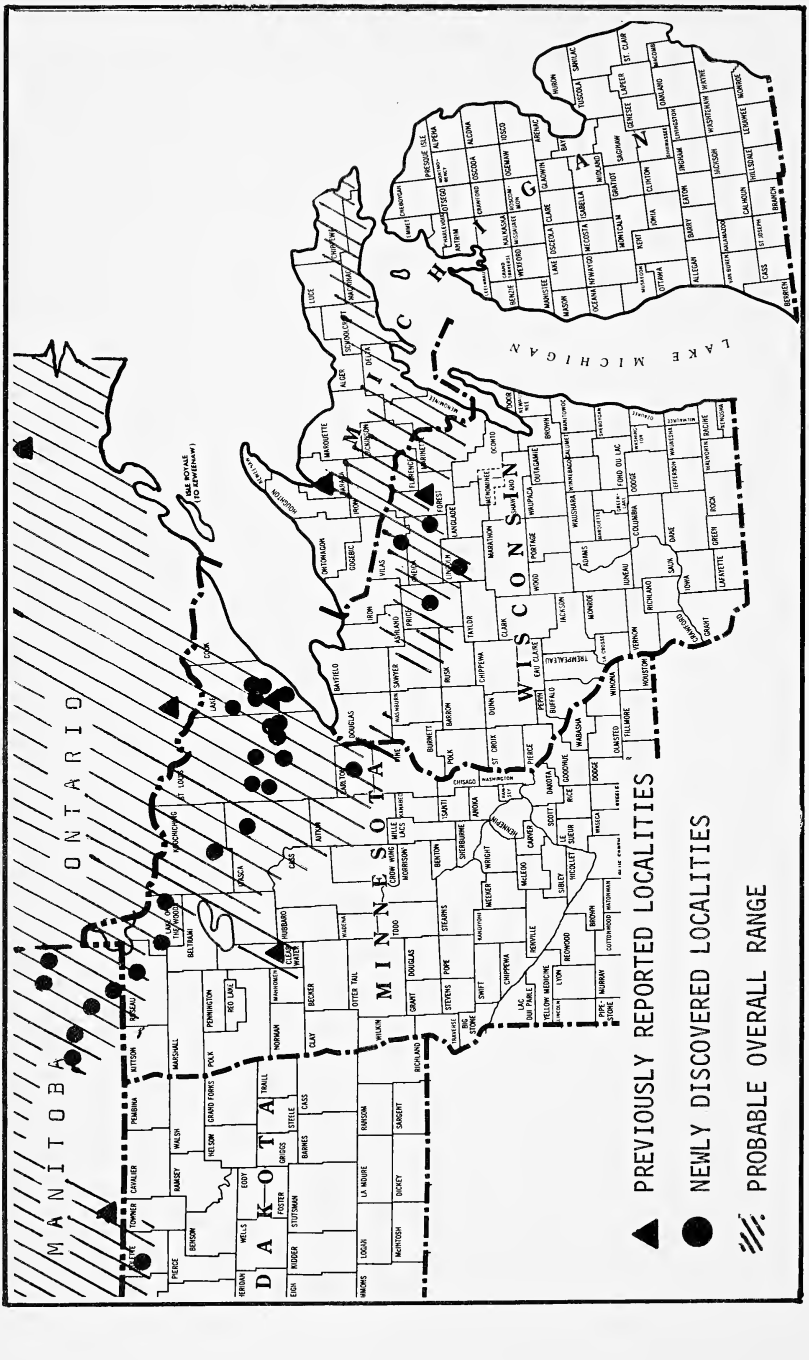


Fig. 1.—Map of the Northcentral Area, showing localities from which *Erebia discoidalis* has been recorded and the suggested overall range.

evening hours when they move into the open areas. *Erebia discoidalis* is fairly conspicuous in flight, normally flying slowly, weakly and close to the ground, but, if alarmed, can quickly rise into the wind to be blown out of range in what Ehrlich (1956) refers to as "the tundra butterflies favorite tactic". At other times, an alarmed butterfly will "dig" into the grass or sphagnum mat, rather than taking wing, in order to avoid a would be predator or captor. They normally light down low in the grass or sphagnum and I have never seen them light on tree trunks in the manner of *Erebia disa,* nor have I ever observed them to visit flowers of any kind. Unlike *Oeneis* sp. (see Masters and Sorensen, 1969) they are not "territorial" nor are they "pugnacious" towards each other or other butterflies. Mate seeking by males seems to be a weak form of patrolling without orientation.

Erebia discoidalis has a decided flight preference for early morning (before 10:00 A.M.) or late afternoon (after 4:00 P.M.) flight, in this respect being much like *Erebia disa* (Masters, 1969). Mid-day flight seems to be stronger on partly cloudy or overcast days, but they avoid flying in rain or on heavily clouded days. Miller (1968) suggests that the crepuscular flight habits of many satyrid butterflies may be a mechanism by which they try to approximate the light intensity conditions of the deep forest (which is apparently the ancestral habitat of the Satyridae). This explanation seems only partially satisfactory to me since many species that are still associated with deep forest conditions (e.g. *Erebia disa*) also exhibit pronounced crepuscular activity. On a couple of occasions, I have observed male *discoidalis* sitting at cool damp spots in a gravel road during the hot afternoon hours.

The seasonal flight of *Erebia discoidalis* is quite early; specimens have been taken in the Northcentral States as early as May 10th and as late as June 18th with peak flights usually occurring during the last week of May. Only *Celastrina argiolus* Linnaeus and hibernating *Polygonia* and *Nymphalis* spp. are on the wing earlier. *Incisalia augustinus* Westwood and *Boloria freija* Thunberg fly at approximately the same time while *Pieris*

napi Linnaeus and *Incisalia niphon* Hubner are a week to ten days later. *Erebia discoidalis* has an annual flight and apparently a one year life cycle, unlike *Erebia claudia* (and possibly *Erebia disa*) which has a biennial flight and a two year life cycle. However, there does seem to be considerable fluctuation in numbers from year to year; Krivda (1968) attributed this to predation by a field mouse, *Microtus pensylvanicus drummondi*.

There is one large field at McNair, Lake County, Minnesota where *Erebia discoidalis* occurs abundantly in a non-bog environment and Krivda (1968) records it in a similar field at The Pas, Manitoba. Interestingly, both of these fields are at the site of former saw mills and contain considerable amounts of sawdust, which creates very acid conditions, in their soils. Also, both sites are surrounded by bogs. Krivda established that the larval food plant at the field at The Pas is *Poa lucida*, an acid loving grass that is not native to the region. Since all of the other localities from which *Erebia discoidalis* has been observed in the Northcentral Region have been bogs, I consider these two sites atypic. For the population west of the Rockies (ssp. *mcdunnoughi* dosPassos) the typical habitat may be somewhat different. Ehrlich (1956) spoke of it as "an insect of open, dry, grassy areas" occasionally "at or above treeline but definitely not a tundra species."

The map (Fig. 1) indicates those localities in the Northcentral States, and adjacent portions of Canada, where *Erebia discoidalis* has been taken. These records are summarized below:

MANITOBA: Cartwright, E.F. Heath (Wolly-Dod, 1916); Sandilands Prov. Forest, several localities from Richer to Piney, WAB, PJC, JHM, JP, CSQ, JTS; Seven Sisters, CSQ; Whiteshell Prov. Park, JHM. The localities cited are all from southeastern Manitoba, for other Manitoba records refer to Brooks (1942) or Masters (1970).

MICHIGAN: Barga County, 3 miles southwest of Baraga, JHM (Nielsen, 1970).

MINNESOTA: Carlton County, Fond du Lac State Forest, JHM; Clearwater County, Itasca State Park, (Daggy, 1936); Itasca

County, near Togo, WAB; Koochiching County, Northwest of Craigville, JTS; Lake County, McNair, RLH (1965), EMB, WAB, JHM, JSN, JTS, 4 miles south of McNair, JHM, Norshore Junction, JHM, PJC, Jordan, PJC, Alseth Lake, WAB, near Farm Lake, WAB, JHM; Lake of the Woods County, Carp, JSN, Norris Camp, NF; Roseau County, Roseau, NF; Saint Louis County, Linden Grove, WAB, PJC, RLH, JHM, JSN, Cook, WAB, JHM, nr. Pfeiffer Lake, WAB, Brimson, JHM, Toimi RLH, JHM, JTS, Fairbanks, JHM, Makinen, JHM.

NORTH DAKOTA: Rolette County, Turtle Mountains, JHM.

ONTARIO: Riotte (1970) records the following localities in Northern Ontario: Charlton, Driftwood, Fort Severn, Geraldton, Lansdown House, Longlac (30 miles east of), Malachi, Monteith, Nakina, Quetico Park, Smoky Falls, Sudbury.

WISCONSIN: Forest County, Argonne, Elder (1961); Lincoln County, Highway 8 between Tripoli and Bradley, JHM; Oneida County, 2 miles north of Rhinelander, JHM; Price County, near Phillips, JHM; Vilas County, four miles west of Eagle River, JHM.

Collectors cited by initials: EMB, Dr. E. M. Brackney, Minneapolis; PJC, Patrick J. Conway, Chicago; WAB, William A. Bergman, Minneapolis; RLH, Ronald L. Huber, Saint Paul; NF, Norman Flagstaff Jr., Roseau, Minnesota; JHM, John H. Masters; JSN, John S. Nordin, Webster, South Dakota; JP, John Polusny, Winnipeg; CSJ, C. S. Quelch, Transona, Manitoba; JTS, John T. Sorensen, Minneapolis.

LITERATURE CITED

BROOKS, G. S., 1942. A check list of the butterflies of Manitoba. *Canadian Ent.* 74: 31-36.

DAGGY, R. H., 1936. New butterfly record for United States (Lepid.: Nymphalidae). *Ent. News* 47: 52.

EHRLICH, P. R., 1956. Ecological observations on *Erebia* (Lepidoptera: Satyridae) in northwestern America. *Ent. News* 67: 28-36.

ELDER, W. H., 1961. Early record of *Erebia discoidalis* (Satyridae) in Wisconsin. *Jour. Lepid. Soc.* 15: 85-86.

HUBER, R. L., 1965. Probable second U.S. record for *Erebia discoidalis*. *Jour. Lepid. Soc.* 19: 76.

KRIVDA, W. V., 1968. Notes on *Erebia discoidalis* (Kirby) and its food plant at The Pas, Manitoba (Lepidoptera: Satyridae). *Bull. Assoc. Minnesota Ent.* 2: 47-49.

MASTERS, J. H., 1969. Ecological and distributional notes on *Erebia disa* (Satyridae) in Central Canada. *Jour. Research Lepid.* 7: 19-22.

———, 1970. Ecological and distributional notes on butterflies of the genus *Erebia* in Manitoba. *The Bluejay* (Regina, Saskatchewan), in press.

MASTERS, J. H. and J. T. SORENSEN, 1969. Field observations on forest *Oeneis* (Satyridae). *J. Lepid. Soc.* 23: 155-161.

MILLER, L. D., 1968. The higher classification, phylogeny and zoogeography of the Satyridae (Lepidoptera). *Memoirs American Ent. Soc.* 24: 1-174.

NIELSEN, M. C., 1970. New Michigan butterfly records. *Jour. Lepid. Soc.* 24: 42-47.

WOLLEY-DOD, F. H., 1916. The Heath collection of Lepidoptera. *Canadian Entomologist*, 48: 161-167.

Journal of Research on the Lepidoptera 9(1):17-20, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A NEW SUBSPECIES OF *EUPHYDRYAS* FROM WYOMING (NYMPHALIDAE)[1]

CLIFFORD D. FERRIS

University of Wyoming, Laramie, Wy. 82070

FORTY YEARS AGO, A. B. Klots (1930) published a paper which discussed several species of Wyoming Rhopalocera. In this paper, there was a brief discussion of *Euphydryas editha* (Boisduval) from the Snowy Range, Albany Co., Wyoming. The insect was not described and the only comment made was that the species should be nearest to *E. editha hutchinsi* form *montanus* McDunnough.

In 1969, colonies of *E. editha* were found in Albany Co.: Sherman Range (East of Laramie) and Snowy Range (near Centennial), and Carbon Co.: Sierra Madre mountains. The specimens collected appear relatively uniform in facies and sufficiently distinct from other known subspecies to warrant a name. The subspecies is being named in honor of Dr. Alexander B. Klots who published the first collection records for it. Since the name *klotsi* dos Passos has already been applied to a member of the *chalcedona* group, to avoid possible confusion, the new subspecific name has been derived from the first three letters of Dr. Klots's given names and the first letter of his surname.

Euphydryas editha alebarki Ssp. Nov.

Male: Palpi orange, pale yellow at base. Antennae orange. Thorax and wings (dorsal) basally blackish with blue-black irridescent overscaling. Abdomen black (dorsally) and ringed with four yellow-orange bands distally; ventral surface centrally white with defining orange lines. Costal margin of primaries orange, broadened basally. Primary cell with two orange bars edged with dark brown, on whitish background. With reference to the accompanying plate, the spot bands on the primaries,

[1]This paper is published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 432.

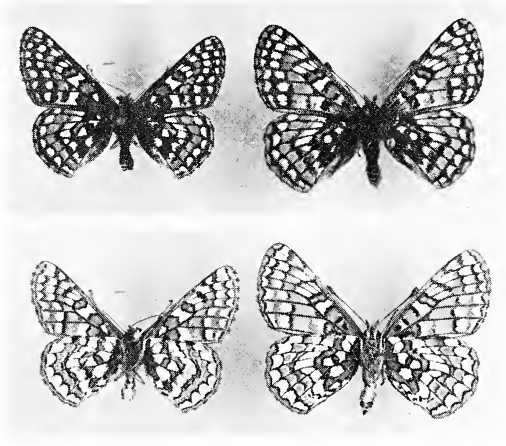


Fig. 1.—Dorsal and ventral surfaces of holotype male (left) and allotype female (right) of *Euphydryas editha alebarki.*

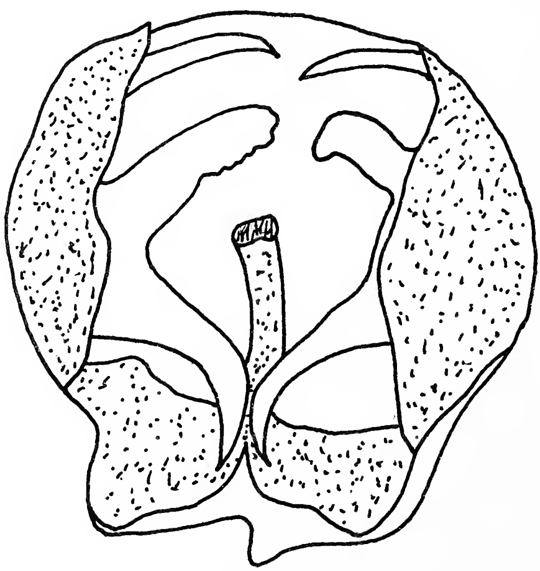


Fig. 2.—Male genitalic structures viewed from end of abdomen after covering hairs have been removed.

starting with the outer margin, are: narrow somewhat diffuse orange band of small elongated quadrate spots, band of whitish spots ringed with orange, postmedian band of generally quadrate whitish spots ringed by a few orange scales, median band of orange spots. In the same order, the spot bands on the secondaries are: marginal row of elongated orange quadrate spots, band of whitish spots circled by a dusting of orange scales, band of large generally quadrate orange spots, band of whitish spots distally bordered by orange, cell-end spot orange, remaining basal spots white. On both wings, the dark ground color is dark brown, but appears black to the unaided eye. There are long hairs on the upper surface of the wings basally. The whitish color when observed under a low-power microscope is almost pure white. There are generally a few orange scales bordering the white areas which produce the overall off-white color. The wing fringes are checkered with brown and white.

Ventrally the general pattern of the dorsal surface is repeated, but the white areas are much more expanded and orange generally replaces the dark ground color. The bands are defined by narrow brown margins. The overall appearance is orange and white with brown pencilling.

Female: Generally similar to the male. Dorsally the whitish areas are more cream-colored even to a very pale yellow. The spots in the bands are larger than in the male and the median orange band on the primaries is smeared in aspect. The costal end of this band shows three pronounced cream spots, which while present in the male, are much less prominent. The basal hairs exhibit some orange. Ventrally the colors are more intense and the brown lines of the male are more nearly black in the female. Expanse (costal margin length): ♂ 1.6 cm. ♀ 1.8 cm.

Although this species was first collected in the Snowy Range, Albany Co., and the colony still exists, the type series is being named from material taken in Carbon Co. The reason for this is as follows: In both the Sherman Range and the Snowy Range, *E. editha* is sympatric with *E. anicia* (Doubleday). *E. anicia* exhibits a cline which runs from *bernadetta* Leussler through *eurytion* (Mead) to *capella* (Barnes). In many cases, *editha* cannot be separated from *anicia* by facies. For the male, the genitalia are distinctive, but the females are in doubt unless a coupled pair can be taken. To date, only *E. editha* has been taken at the Carbon Co. location, so that the females are determined by direct association with the males.

The type series consists of four males and four females taken by the author on 30-v-69 and 5-vi-69. Other series of the insect were also taken in the two Albany Co. locations cited.

Holotype. — ♂, Medicine Bow N. F., about 10 miles S.W. of Encampment on Battle Lake Road, Sierra Madre mountains, 8600′, Carbon Co., Wyoming, 5 June, 1969.

Allotype. — ♀, Same locality as male on 30 May, 1969.

Paratypes. — 3 ♂ on same date as holotype and 3 ♀ on same date as allotype. No distribution of the type series has as yet been made as the material is currently needed for a continuing study of Wyoming Rhopalocera. The type series is in the collection of the author. Specimens from the Snowy Range are in the collection of the American Museum of Natural History.

Other locations at which this species has been taken are: Pole Mountain, Sherman Range, 8500′, Medicine Bow N. F., Albany Co., and near the University of Wyoming Science Camp, Medicine Bow N. F., Snowy Range, 9900′, Albany Co., Wyoming. The butterfly is found in open areas from the Upper Transition to the Lower Canadian Zones. Depending upon the year, it flies from late May into July.

In facies, this species is intermediate between *hutchinsi* McDunnough and a new species being described from Ouray Co., Colorado by F. M. Brown. It is not so dark as *hutchinsi,* described by McDunnough (1928) as "blackish," but is distinctly darker than the orange-yellow insect from Colorado. The Wyoming type series has been compared with the paratypes of *hutchinsi* and with the Ouray Co., Colorado type series. *E. editha hutchinsi* is known from the northern part of Wyoming (Sublette Co. and north) and in the dark alpine form *montanus* from Yellowstone National Park. The new subspecies *alebarki* is quite distinct from *montanus.*

ACKNOWLEDGEMENTS

The author would like to thank F. M. Brown of Colorado Springs, Colorado for his comments and suggestions in the preparation of this paper, and for making available the Ouray Co. specimens for examination. Dr. Norman Anderson, Montana State University, Bozeman kindly loaned the paratypes of *hutchinsi* for examination.

LITERATURE CITED

KLOTS, A. B. 1930. Diurnal Lepidoptera from Wyoming and Colorado. *Bull. Brooklyn Ent. Soc.* 25:147-170.

McDUNNOUGH, J. H. 1928. A new Euphydryas (Lepidoptera). *Canad. Ent.* 60:248-249.

Journal of Research on the Lepidoptera 9(1):21-23, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

EUPHYDRYAS EDITHA GUNNISONENSIS, A NEW SUBSPECIES FROM WESTERN COLORADO

F. MARTIN BROWN

Fountain Valley School,
Colorado Springs, Colo. 80911

For some years I have had a modest series of *Euphydryas editha* from the western slope of Colorado. It is quite distinctive and at first glance gives the impression of an orange-fulvous and yellow butterfly. It is sporadically common at the type locality in the *Atriplex*-covered land between Owl Creek Pass road and Cow Creek in the northeastern part of Ouray County, Colorado. Scott Ellis tells me that he has found it elsewhere in the Gunnison River drainage in similar terrain.

Euphydryas editha gunnisonensis, n. ssp.

MALE: Radius of the left forewing, 19.0 mm. Upper side: forewing — the outer third of the wing from the margin inwardly is patterned with a narrow, continuous, orange-fulvous marginal band basad of which are two rows of yellow spots set in a broad, blackish-brown band that is almost wholly taken up with the yellow spots. The fringe is black at the tips of the veins and yellow between them with the black and yellow portions subequal. There is a broad, sinuous, orange-fulvous median band. Costad of M_1 and in cell Cu_2 this band is yellow or strongly tinged with yellow. There is a narrow dark bar apicad and parallel to the discocellular veins. Between it and the cell it is yellow crossed with black on the veins. The cell is yellow with two large blocks of orange-fulvous, one terminal, and both margined with black. The base of the cell is black with scattered yellow scales. In cell Cu_2 basad of the median band there are: a nebulous dark patch; a yellow patch; a black-margined orange-fulvous patch and a dusky basal patch dusted with yellow scales.

Hindwing — Moving inward from the margin to the cell there are: a narrow fulvous band basally edged with black; a series of sublunate yellow spots edged with black; a broad postmedian orange-fulvous band, and, a slightly narrower yellow median band. Rows of dark scales on the veins partly dissect the median bands. Posteriorally the basal part of the wing is black with traces of a yellow patch in cell Cu_2. Anteriorly it is orange-fulvous with two yellow patches in the cell separated by a blackish rectangular patch. The fringes are as on the forewing.

FEMALE: Radius of the left forewing, 20.8 mm. Upper side: marked essentially as is the male with the markings somewhat less crisp and the submarginal rows of yellow spots on the forewing somewhat invaded with fulvous. Underside: as on the male.

HOLOTYPE: a male, Owl Creek Pass road 2 miles east of Colo. 550, near Ridgeway, Ouray County, Colorado, 7000 feet above sea level, 9 June 1965. Collected by F. M. Brown.

ALLOTYPE: a female, same data as the holotype.

PARATYPES: 10 males and one female with the same data as the holotype; 10 males from the type locality taken on 2 June 1966; one female, Canyon Creek, west of Ouray, Ouray County, Colorado, 8000 feet above sea level, 10 June 1962; two males and two females at the junction of East Dallas Creek road and Beaver Creek road, 2 miles south of Colo. 62 west of Ridgeway, Ouray County, Colorado, 7400 feet above sea level, 4 June 1966. All of the paratypes were collected by F. M. Brown. The types and paratypes are deposited at the American Museum of Natural History, New York, N.Y., except for one pair of paratypes given to Dr. Cyril F. dos Passos.

One of the paratype males from the lot that supplied the holotype has the forewings somewhat crippled. Another one is aberrant with the apical half of the forewing essentially yellow.

The radius of the left forewing of 20 males from the type locality was measured and the data treated statistically. One of the males proved to be a dwarf with the dimension 15.3 mm. When it is included, the mean radius for the series is 18.01 mm. with a standard deviation of 0.83 mm. If the dwarf is excluded, the mean radius is 18.23 mm. and the standard deviation 0.55 mm.

When *gunnisonensis* is compared with the several closest occurring subspecies of *editha* it is found to much lighter than *lehmani* from Mount Wheeler, Nevada, and to have much more boldly developed rows of light spots in the submargin of the forewing. When compared with the other Rocky Mountain forms of *editha,* to which *gunnisonensis* is most closely allied, it is found to be more brightly colored and to have generally larger yellow spots. As might be expected it is closer to *alebarki* Ferris from Carbon and Albany counties, Wyoming, on the eastern side of the Continental Divide. As Ferris indicated in his original description *alebarki* is distinctly darker than *gunnisonensis* while also being distinctly lighter than either *montanus* McDunnough or *hutchinsoni* McDunnough.

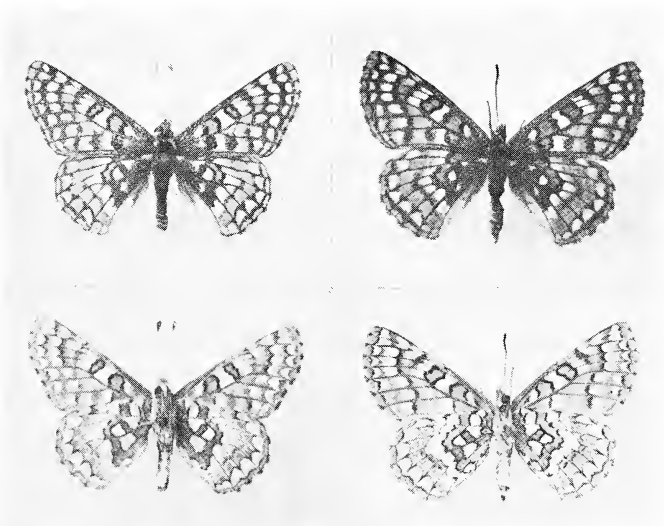


Fig. 1.—*Euphydryas editha gunnisonensis,* holotype (left) and allotype right.

REVIEW

BUTTERFLIES OF TRINIDAD AND TOBAGO

Malcom Barcant D.I.C.T.A. 1970. 314 pages, 28 plates, most in color.

Collins, 14 St. Jame's Place, London, S.W.1. 55s. net.

A handy means for identification of the butterflies of any part of the American tropics is not easy to locate. The present volume will help fill part of the void and it does so well because many of the species (or relatives) discussed here and figured in color are also found in many other parts of the tropical regions extending from the Tropics of Cancer to Capricorn.

The style of presentation is excellent. There is little on detailed description of the insect itself, since the figures speak for themselves. Under each species is indicated: RANGE; DESCRIPTION; HABITS AND HABITAT.

There is a special "Classification of Butterflies, according to habits and environment of adult stage," consisting of six pages of tabular material which should be very useful.

The reviewer believes that a phylogenetic arrangement in the book would be more useful to serious collectors than one based on habits and habitats, though the latter arrangement, secondarily is excellent. The book is recommended to help all collectors interested in tropical American species.

W. Hovanitz

Journal of Research on the Lepidoptera 9(1):25-28, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A FIELD-CAPTURED SCALE-DEFICIENT MUTANT OF *ANTHOCARIS SARA*

ERNST J. DORNFELD
Department of Zoology, Oregon State University
Corvallis, Oregon 97331

THE ORANGE-TIP *Anthocaris sara flora* Wright is an abundant butterfly in the McDonald Forest, a university arboretum just north of Corvallis, Oregon. A normal male specimen from this locality (April 23, 1959) is shown in figure 1. On March 31, 1968 I netted a highly aberrant male (figure 2) which displayed a weak flight and appeared at first impression to be a worn and unaccountably rubbed specimen. Closer inspection showed, on the contrary, that it was in fresh condition but strongly deficient in scaling.

The aberrancy of this specimen (figure 2) is precisely symmetrical. The most striking feature is the extensive loss of scales, these being largely limited, especially on the hind wings, to the veins (figure 3). On the ventral surface this restriction is extremely sharp. The marginal fringe scales are scanty and on the hind wings present only in small patches. The characteristic normal green splotches of the HW underside (intervenous mixtures of black, white, and yellow scales) are completely lacking. The costal margins of the forewings are curled upward, and the extreme lateral wing margins curve downward. The wings in their entirety are noticeably narrowed.

On microscopic examination the scales of the aberrant specimen are seen to be defective (figure 5). For the most part they are narrowed and give the impression of being elongated. To varying degrees their distal pronged margins are ill-defined, reduced, or lacking. Some scales, particularly among those few remaining in the bare regions, are severely dwarfed and variously misshapen. In these areas the scale sockets are exposed and they, too, are conspicuously abnormal. It is apparent that wrinkling of the wing cuticula has occurred, giving rise to radiating ridges

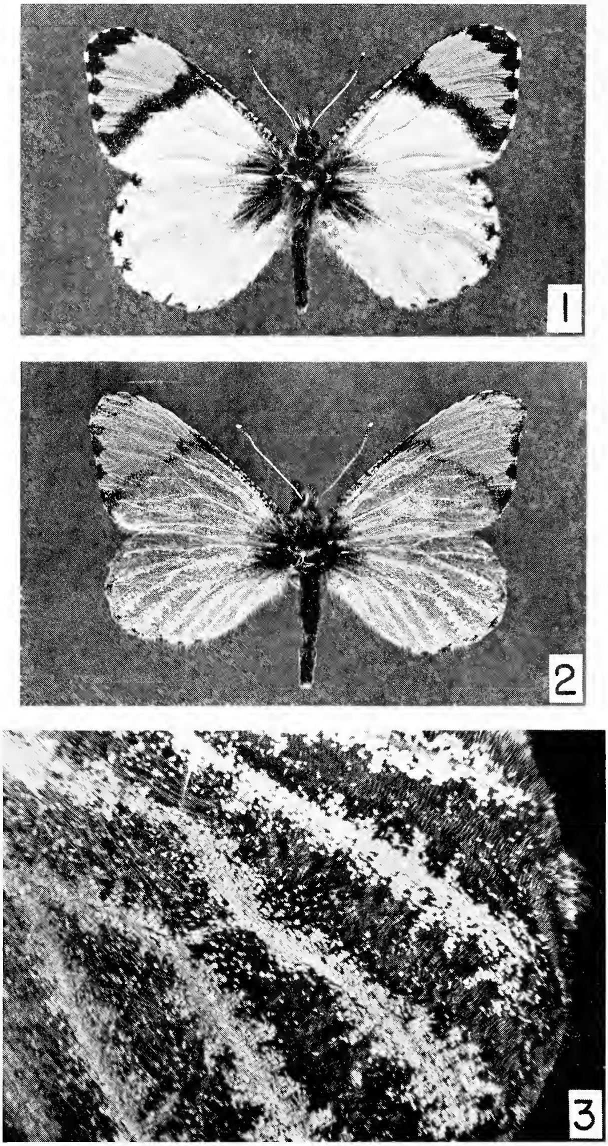


Fig. 1. Normal male of *Anthocaris sara flora* Wright. McDonald Forest, Benton Co., Oregon; April 23, 1959.
Fig. 2. Scale-deficient mutant. McDonald Forest, Benton Co., Oregon; March 31, 1968.
Fig. 3. Magnified portion of right hind wing of mutant. Note restriction of scales to region of veins.

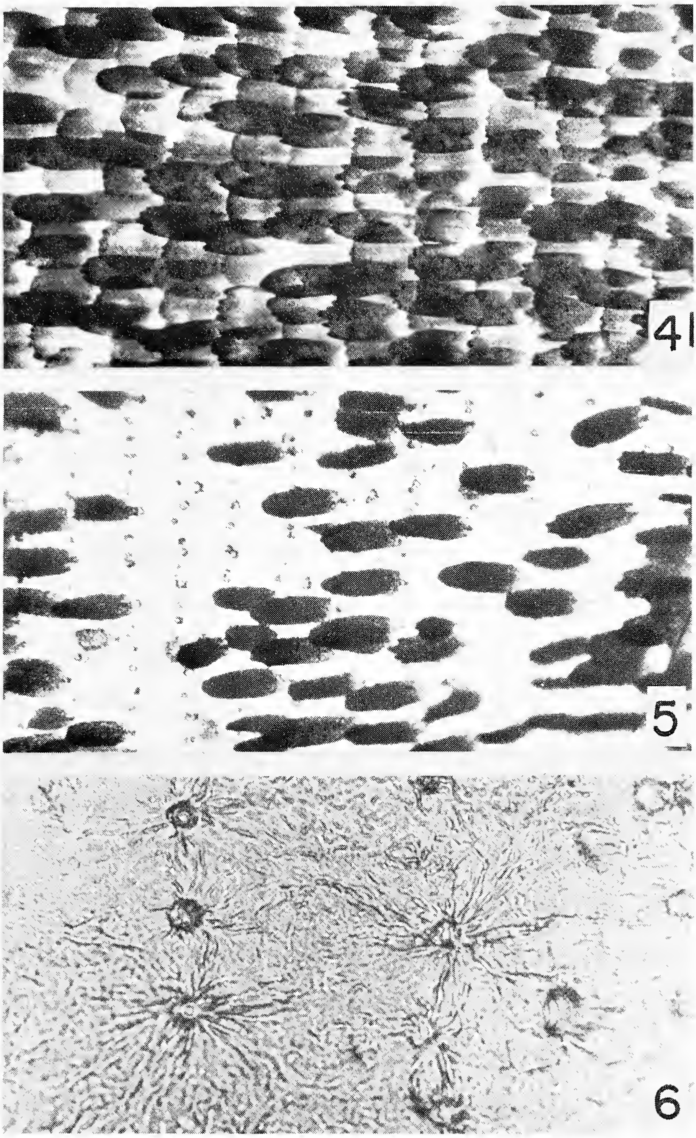


Fig. 4. Scale pattern of normal *Anthocaris* forewing, region of diagonal black crossbar.

Fig. 5. Scale pattern of scale-deficient mutant, same region. Note rows of scale-sockets in bare areas. Remaining scales are narrowed and variously deformed.

Fig. 6. High magnification of scale-deficient area. Note wrinkling of wing surface, with cuticular ridges radiating from deformed scale-sockets.

that emanate from the sockets (figure 6). Loose scales in these regions suggest that they have fallen from the defective sockets.

I have not succeeded in finding in the literature any description of a field-captured aberration of this type. There are, however, accounts of this aberrancy appearing under laboratory conditions in reared populations. A thorough study of such a case was published from the laboratory of Professor Alfred Kühn of the Max-Planck-Institute (Kühn & Berg, 1951; Kühn & Merkel née Berg, 1955). In his cultures of the moth *Ptychopoda seriata* an incompletely dominant mutant appeared with precisely the same aberrant features shown by the present specimen of *Anthocaris*. He termed this mutation *squamis deletis* (symbolized *Sqd*). Moreover, he was able to produce in the meal moth *Ephestia kühniella* exact phenocopies of this mutant condition by exposing the pupa during a limited sensitive period to heat shock (45° C = 112° F) for 45 minutes. A similar experimental observation had been made by Köhler & Feldotto (1937), working with *Vanessa urticae*. It would appear that the mutation involves gene action associated with cuticular development in the pupal stage. Very recently, working with *Pieris rapae*, Kolyer (1970) produced another instance of a heat-induced phenocopy of the *Sqd* mutant type (pupae exposed to 41.4-47.5° C for 20 minutes). His figures 14 and 15 should be compared to figures 2 and 3 of this account.

Considering the symmetrical pattern of the *Anthocaris* aberration, its close resemblance to the *Sqd* mutation of *Ptychopoda*, and the extremely unnatural stimulus required to produce a phenocopy, this specimen in all likelihood represents a mutant individual. Its weak flight pattern (for whatever reason) has been noted, suggesting low chance of survival and a possible reason why this type of aberration does not seem to have been previously reported as a field capture.

LITERATURE CITED

KÖHLER, W., and W. FELDOTTO, 1937. Morphologische und experimentelle Untersuchungen über Farbe, Form und Struktur der Schuppen von *Vanessa urticae* und ihre gegenseitigen Beziehungen. *Roux' Arch.* 136: 313-399.

KÜHN, ALFRED, and ANNELIESE BERG, 1951. Eine neue Mutation mit wechselnder und zeitlich beschränkter Wirkung bei *Ptychopoda seriata*. *Z. Naturforschg.* 6b: 41-44.

KÜHN, ALFRED, and ANNELIESE MERKEL, 1955, Uber einige die Beschuppung des Schmetterlingsflügels beeinflussende Mutationen und Phänokopien. *Biol. Zentralbl.* 74: 113-145.

KOLYER, JOHN M., 1970. Variations in the markings of *Pieris rapae* (Pieridae) induced during the pupal stage. *J. Lepid. Soc.* 24: 125-134.

Journal of Research on the Lepidoptera 9(1):29-64, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

REVISION OF THE NEARCTIC GENUS *PHILTRAEA* HULST, WITH NOTES ON BIOLOGY AND THE DESCRIPTIONS OF NEW SPECIES (GEOMETRIDAE)

JOHN S. BUCKETT[1]

Department of Entomology
University of California
Davis, California

THE PRESENT WORK WAS BEGUN late in 1965 after discussing the apparent confusion within the genus with colleagues Mr. Carl Kirkwood and Dr. Jerry Powell. Through the study of genitalic mounts of both sexes of a number of disjunct populations, it was found that many previously unrecognized species existed within *Philtraea* Hulst. The scope of this revision is to make available names for the undescribed entities as well as to provide previously unrecorded information pertaining to morphology, life histories and distribution. Descriptions, keys ,distribution maps, illustrations and pertinent discussion are included where thought to be of value.

The presently recognized species within the genus are:

1) *Philtraea elegantaria* (Henry Edwards)
2) *P. utahensis* n. sp.
3) *P. surcaliforniae* n. sp.
4) *P. latifoliae* n. sp.
5) *P. mexicana* n. sp.
6) *P. albimaxima* n. sp.
7) *P. paucimacula* Barnes & McDunnough
8) *P. monillata* n. sp.

[1]I would like to extend my appreciation to Dr. R. M. Bohart, Department of Entomology, University of California, Davis for his suggestions and criticisms; to Mrs. Karen Fulk and to Mr. Michael R. Gardner for most of the illustrations; to Mrs. Twila Feeman for final typing of the manuscript. Also the following individuals are acknowledged for their assistance, and/or notes and loan of specimens: Dr. Paul H. Arnaud, Jr., California Academy of Sciences, San Francisco; Mr. William R. Bauer, Bureau of Entomology, California Department of Agriculture, Sacramento; Mr. Chris Henne, Pearblossom, California; Mr. Peter M. Jump, San Jose State College, San Jose; Mr. Carl W. Kirkwood, Summerland, California; Mr. A. T. McClay, Department of Entomology, University of California, Davis (present address Department of Entomology, University of Missouri, Columbia, Missouri); Mr. A. Noel McFarland, Valyermo, California (presently at South Australian Museum, Adelaide, South Australia); Dr. Jerry A. Powell, California Insect Survey, University of California, Berkeley; Dr. Frederick H. Rindge, Ameican Museum of Natural History, New York; Dr. E. L. Todd, United States National Museum, Washington D. C.

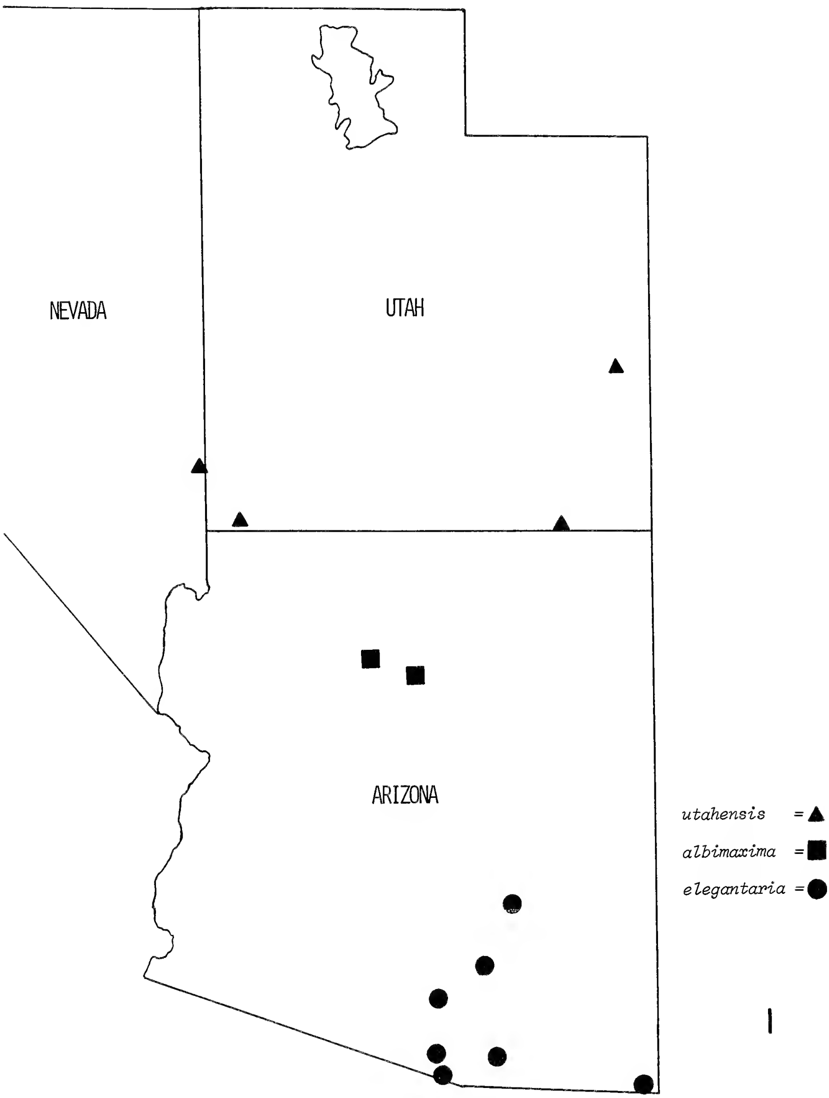


Fig. 1.—Distribution map depicting the known range of *Philtraea elegantaria* (Hy. Edw.), *P. albimaxima* Bkt., and *P. utahensis* Bkt.

The author presently recognizes three species groups within *Philtraea,* the most obvious diagnostic feature used to define these groups being the shape of the juxta of the male genitalia and the shape of the ductus seminalis of the female genitalia. Superficially, the adults are somewhat similar interspecifically, and share the same dorsal ground color of the primaries, which is white, and to a lesser degree, the two transverse gold colored bars also found on the dorsal surface of the primaries.

The genus *Philtraea* was first proposed by Hulst (1896) for the species *elegantaria* (Hy. Edw.). At the time of the original description of *elegantaria,* Edwards had placed this species in the genus *Zerene* Hubner, close "to the well known *catenaria.*" *Zerene* is presently applied to a subgenus of butterflies, and the species *catenaria* Drury is presently in the genus *Cingilia* Walker. Barnes and McDunnough (1918) described *paucimacula,* a new variety of *elegantaria,* and placed it also in the genus *Philtraea,* thus bringing the total of named entities within the genus up to two. Until this present work, *elegantaria* and *paucimacula* have been the only described entities within *Philtraea.*

To date some information has been accumulated pertaining to the immature stages of members within the genus, but considering the group as a whole, much work has yet to be done. The reliability of some of the hostplant data may be questionable, as they were taken from labels affixed to specimens. Larvae of *P. latifoliae* n. sp. have been personally collected on Oregon Ash (*Fraxinus latifolia* Benth.) and reared to adulthood by Mr. A. Noel McFarland. A description of the larva can be found under the elaboration in the descriptive section pertaining to *P. latifoliae.*

Other indications of hostplants from labels read "bd. privet," or "on weeds." The latter reference to "weeds" indicates that perhaps *paucimacula* at least, may be an herbaceous feeder on one or more smaller plant species. Still another species, *monillata* n. sp. apparently feeds on "privet" in the larval stage of the first generation, whereas information is lacking for the second, or late summer generation of this species. However, it would most likely still feed on "privet".

The pupae of *Philtraea* are brightly colored in instances where they have been observed. The ground color is predominently white, with some yellowish coloration and overlain with black flecks. In *latifoliae,* the pupa is enclosed in a

Fig. 2.—Distribution map depicting the known range of *P. latifoliae* Bkt.; the known range of *P. surcaliforniae* Bkt. is complete except for omission of the single record from La Paz, Baja California, Sur, Mexico (mentioned in "Specimens examined" section for this species).

"weak cocoon," or an "open net," and is easily seen through this netting (see fig. 21). It is probable that other species within the genus also exhibit this same construction pattern.

To my knowledge, the literature pertaining to *Philtraea* does not reveal any known predators or parasites.

The known distribution of *Philtraea* indicates that the genus is confined to the Nearctic, with most of the species occurring in the area of the southern United States. In general, the species within the genus are found between 85° longitude to 124° longitude, and 25° north latitude to 38° north latitude. In California, *surcaliforniae* n. sp. has been collected at sea level, and *mexicana* n. sp. has been collected at an elevation of 7,500 feet in Chihuahua, Mexico (see distribution map, fig. 3).

Philtraea Hulst

TYPE: *Zerene elegantaria* Henry Edwards, 1881. Papilio 1:121.

Philtraea Hulst, 1896. Trans. American Entomol. Soc. 23:364-365; Dyar, 1903 (1902), Bull. U.S. Nat. Mus., No. 52:331; Barnes and McDunnough, 1917, Check list of the Lepidoptera of Boreal America, p. 119; 1918, Contrib. Nat. Hist. Lep. of N. America 4(2):154 + pl. 20, figs. 2 and 3; Comstock, J. A., 1934, Bull. of S. Calif. Acad. Sci. 33(1):35-36 + pls. 16 and 17; McDunnough, 1938, Mem. S. Calif. Acad. Sci. 1:170.

Head: Antennae in both sexes bipectinate, bipectinations in male longer than in female; frons with integument roughened, or more or less smooth, clothed in whitish, yellowish or golden scales and elongate hairs; maxillary palpi rudimentary; proboscis vestigial in male, in female small, nearly rudimentary. Thorax with collar and tegulae clothed in white elongate scales and hairs; posterior marginal fold of alinotum of mesothorax greatly pronounced so as to transversely divide vestiture between meso and metathorax; primaries in male lacking fovae, ventrally clothed in white scales and elongate hairs; legs normal, meso and meta-tibiae each possessing a pair of end spurs; venation of wings generalized as in figs. 31 and 32. Abdomen clothed in predominence of white scales. Greatest expanse of forewing varies from 9 mm to 22+ mm. Genitalia as in illustrations.

Philtraea seems best placed at, or near where it was placed by McDunnough (1938) in his check list. By genitalia *Philtraea* exhibits the same general type as does *Plataea* Herrich-Schaeffer, *Enypia* Hulst, and *Nepytia* Hulst. By maculation of the primaries, *Philtraea* stands as a unique genus in the Nearctic Ennominae.

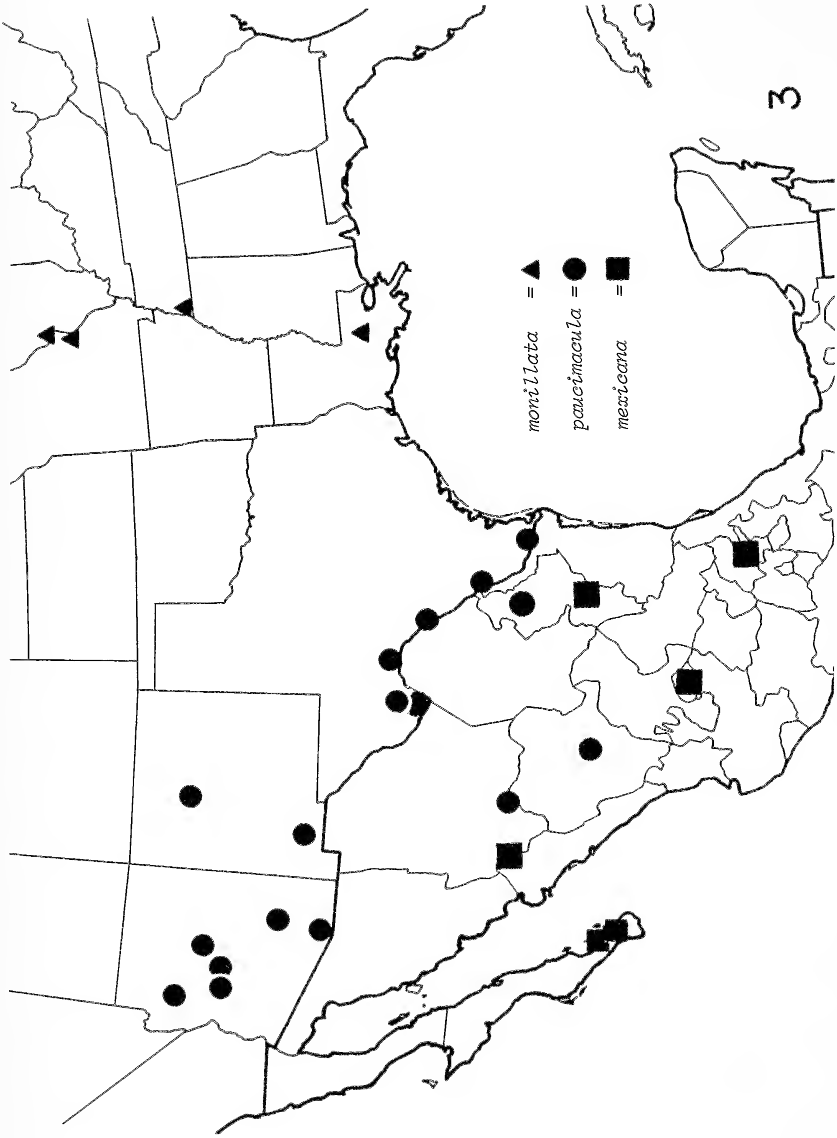


Fig. 3.—Distribution map depicting the known range of *P. monillata* Bkt., *P. paucimacula* B. & McD., and *P. mexicana* Bkt.

Keys to species of *Philtraea* by use of color and maculation

1. Ventral surface of primaries dusky to fuscous in male; dorsal surface of primaries not possessing much yellow between geminate transverse anterior and transverse posterior lines, or if yellow is easily discernible, then much black coloration accompanying lines 2

   Ventral surface of primaries whitish, or if slightly dusky, dorsal surface with transverse anterior and transverse posterior lines possessing much yellow, usually lacking prominent black coloration of lines 3

2. Greatest expanse of forewing 20mm or greater; dorsal surface of primaries with ground color whitish, little yellow between geminate transverse anterior and transverse posterior lines; ventral surface of primaries dusky, not fuscous; secondaries dorsally whitish, lacking prominent black dots (which form disjunct exterior line); known to occur in Arizona and Mexico 6

   Greatest expanse of forewing 19mm, averaging less than 18mm; dorsal surface of primaries with very distinct markings, transverse anterior and transverse posterior lines geminate, filled with bright yellowish; secondaries with black dots forming disjunct exterior line (more prominent in males than in females); ventral surface of primaries fuscous; known to occur in northern California .... *latifoliae,* n. sp.

3. Greatest expanse of forewing 20mm; distance between junction of tranverse anterior and transverse posterior lines on inner margin proportionately greater than in remaining species (as in fig. 9); "U" shaped geminate line between transverse anterior and transverse posterior lines broadly open costally; known to occur in Southern California .... *surcaliforniae,* n. sp.

   Greatest expanse of forewing variable, from 10mm to 18mm, but seldom does a specimen exceed 18mm in this measurement; distance between transverse anterior and transverse posterior lines on inner margin proportionately less than in *surcaliforniae;* "O" or "U" shaped geminate line between transverse anterior and transverse posterior lines closed (to form a circle), or narrowly open costally (as in fig. 4); species known to occur in the southern United States, but not thus far in California 4

4. Dorsal surface of primaries with transverse anterior and transverse posterior lines geminate, much black coloration to lines (as in fig. 4); very prominent maculation; greatest expanse of forewing averaging nearly 16mm, little size variation (with the exception of an occasional runt); known to occur in Arizona; genitalia as in figs. 24, 33 and 41. .... *elegantaria* (Hy. Edw.)

   Dorsal surface of primaries with transverse anterior and transverse posterior lines geminate, but black coloration not as prominent as in preceding (e.g. figs. 5, 6 and 15); yellow inner filling of transverse anterior and transverse posterior lines prominent or maculation may be greatly reduced; greatest expanse of forewing from 10mm to 18mm 5

5. Primaries with "U" shaped mark at costa between transverse anterior and transverse posterior lines; transverse lines of primaries yellow, not too prominent, little black bordering these lines; genitalia as in figs. 22, 34 and 42. ....*utahensis* n. sp.

   Primaries with "O" or "U" shaped mark on costa; transverse lines of primaries very conspicuously yellow; male genitalia as in figs. 28, 29, 30, 38, 39. 7

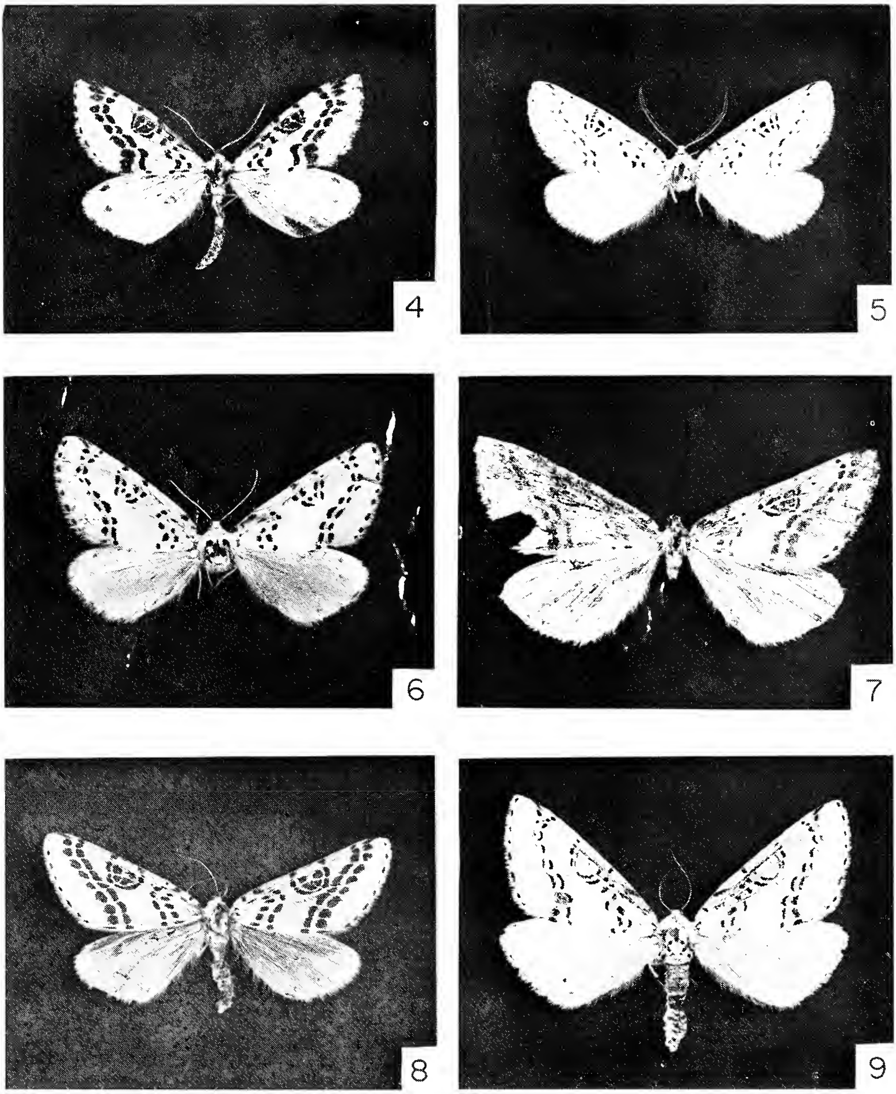


Fig. 4.—*Philtraea elegantaria* (Hy. Edw.), male. ARIZONA: Baboquivari Mountains, 26 April 1958 (G.H. & J.L. Sperry). Fig. 5.—*P. utahensis* Bkt., holotype male. UTAH: St. George, Washington County, June, (slide no. 4615, F.H. Rindge). Fig. 6.—*P. utahensis,* allotype female (abdomen missing). Same data as holotype. Fig. 7.—*P. mexicana* Bkt., holotype male. MEXICO: no further data, (R. Muller), Bauer-Buckett slide no. 67D10-21. Fig. 8.—*P. mexicana,* allotype female. MEXICO: 3 miles east of Galeana, Nuevo Leon, 7-9 August 1963, 5,000 ft. elevation (W.D. Duckworth and D.R. Davis). Fig. 9.—*P. surcaliforniae* Bkt., paratype female. CALIFORNIA: San Marcos Pass, north of Santa Barbara, Santa Barbara County, 4 July 1965 (J.S. Buckett).

6. Ventral surface of primaries in male conspicuously dusky; transverse anterior and transverse posterior lines on primaries not prominent; "O" or "U" shaped mark between transverse anterior and transverse posterior lines nearly wanting; known to occur in Arizona. .... *albimaxima* n. sp.
   Ventral surface of primaries in male off white in color, but not conspicuously dusky; transverse anterior and transverse posterior lines prominent; "U" shaped mark prominent; thus far found on the plateau and western portions of Mexico. ....*mexicana* n. sp.

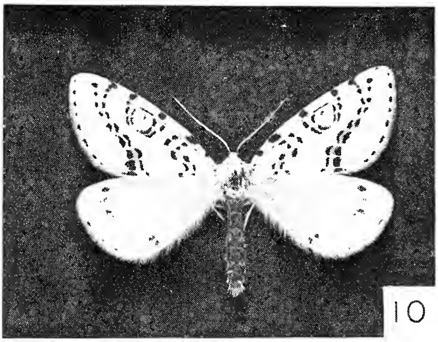
7. Transverse lines of primaries very broad (as in figs. 16, 17 and 18); species exhibiting apparent bivoltinism, the second brood with specimens diminutive in size; known to occur along the Mississippi River (see fig. 3); genitalia as in figs. 30, 39 and 48. .... *monillata* n. sp.
   Transverse lines of primaries much narrower (as in figs. 14 and 15); little evidence of bivoltinism (one record seen which might indicate second brood); widespread from Arizona eastward into Texas and south into northern Mexico; may exhibit a pale form with maculation nearly wanting; genitalia as in figs. 28, 29, 38 and 47. .... *paucimaculata* Barnes and McDunnough

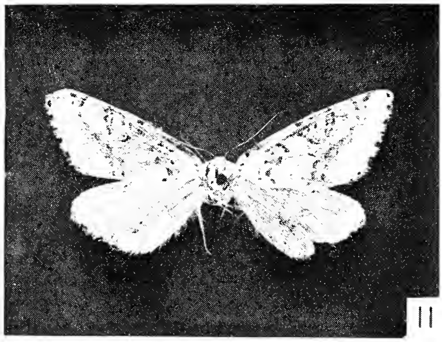
Philtraea elegantaria (Henry Edwards)
(Figs. 1, 4, 19, 24, 31, 32, 33, 41)

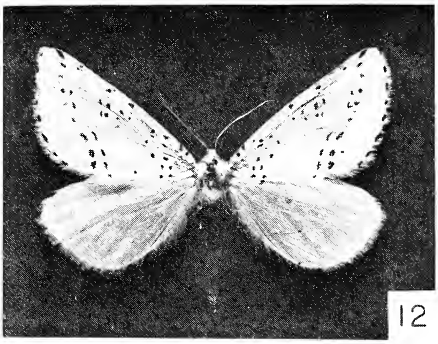
Zerene elegantaria Henry Edwards, 1881, Papilio 1:121.

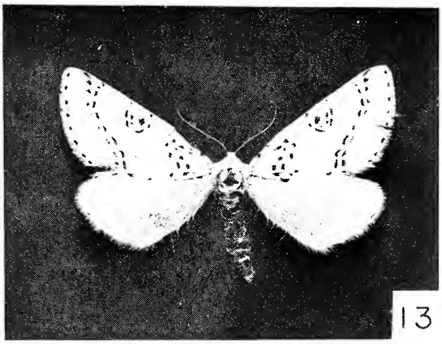
Philtraea elegantaria, G. D. Hulst, 1896, Trans. American Entomol. Soc. 23:364-365; Dyar, 1903 (1902), Bull. U. S. Nat. Mus., No. 52:331; Barnes & McDunnough, 1917, Check list of the Lepidoptera of Boreal America, pg. 119; Comstock, J. A., 1934, Bull. S. Calif. Acad. Sci. 33(1):35-36 + pls. 16 and 17; McDunnough, 1938, Mem. S. Calif. Acad. Sci. 1:170.

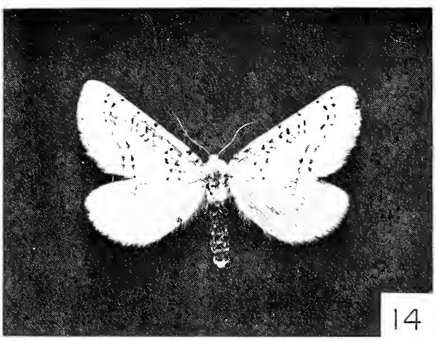
Male: Ground color of primaries white; maculation prominent; transverse lines with considerable amount of dark scalation. Head with vertex clothed in whitish and yellowish elongate hairs, yellowish ones being nearest frons; frons clothed with white scales and yellowish elongate hairs, integument roughened, granulated; palpi diminutive, slightly upturned, clothed in white hairs, ventrally clothed sparsely in elongate white hairs; proboscis vestigial; compound eyes very large, conspicuous; antennae heavily bipectinate, each pectination possessing minute setae, scape and pedicel clothed in white scales, as is dorsal portion of antennae. Thorax dorsally with divided collar composed of white elongate scales and elongate hairs; tegulae clothed basally in yellowish scales and hairs, clothed terminally in elongate white hairs; disc composed of white and yellow scales, but may appear either yellowish or whitish to the unaided eye, ventrally clothed in whitish scales and hairs (easily rubbed off), as are legs; primaries dorsally with ground color white; basal line suggested costally by dark brown dash (this


10


11


12


13


14

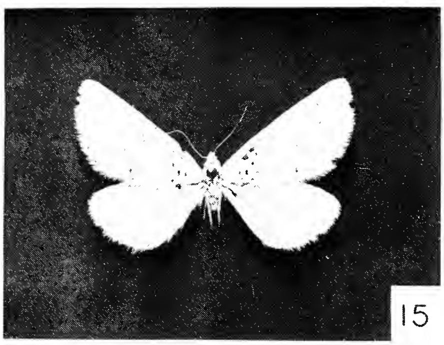

15

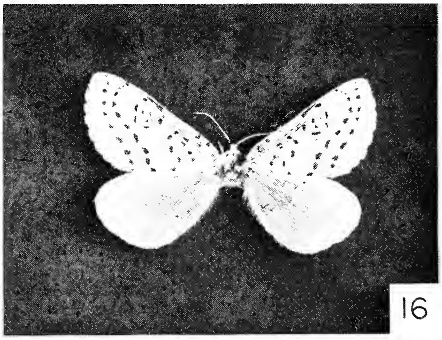
Fig. 10.—R. *latifoliae* Bkt., holotype male. CALIFORNIA: 8+ miles west of Winters, in Solano County, 8 May 1964, ex. *Fraxinus latifolia* (A.N. McFarland, J.S. Buckett and M.R. Gardner), Bauer-Buckett slide no. 67K29-21. Fig. 11.—*P. latifoliae*, allotype female. CALIFORNIA: Vacaville, Solano County, 13 July 1948 (A.T. McClay), Bauer-Buckett slide no. 66B6-21. Fig. 12.—*P. albimaxima* Bkt., holotype male. ARIZONA: Oak Creek Canyon, 15 miles north of Sedona, Coconino County, elevation 5,000 ft., collected at 6:15 AM, 21 July 1965 (F. Thorne). Fig. 13.—*P. albimaxima*, allotype female. ARIZONA: 7 miles west of Williams, Coconino County, 23-28 July 1957 (A.N. McFarland). Fig. 14.—*P. paucimacula* B. & McD., female. TEXAS: Sanderson, Terrell County, 1 April 1953 (Otto Buchholz). Fig. 15.—*P. paucimacula*, female. ARIZONA: Prescott, Yavapai County, 29 April 1961, elevation 5,400' (R.F. Sternitzky), Bauer-Buckett silde no. 66B3-35. Note light color form, obscure maculation.

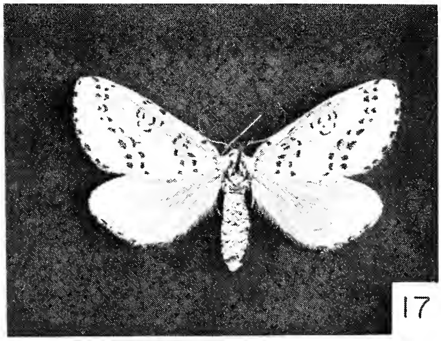
dash may also be considered part of the broadly geminate transverse anterior line), costa clothed basally in brown scales; transverse anterior line geminate, brown portions of line disjunct, whereas inner medial yellow is nearly continuous, outcurved from costa to inner margin (as in fig. 4.); median area white; apparent reniform or "U" or "O" shaped mark closed costally, multicolored, outer discontinuous band dark brown, thence inwardly a complete yellowish ring, thence with two transversely directed brown bands, medially white; transverse posterior line geminate, colored as in transverse anterior line; terminal area white; terminal line represented by dark brown lunules between veins; fringes white; ventral surface whitish; all maculation of dorsal surface visible through wing when viewed ventrally; secondaries dorsally whitish; may be faint suggestion of lunules between veins forming terminal line; ventral surface as in dorsal surface. Abdomen both dorsally and ventrally clothed predominently in white scales, a few white hairs present also. Greatest expanse of forewing averages very nearly 16mm. Genitalia as in figs. 24 and 33.

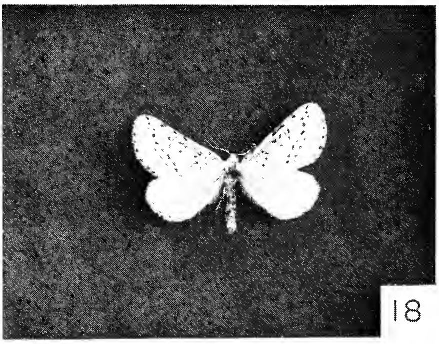
Female: As in male, except antennal pectinations shorter; greatest expanse of forewing may average slightly larger than in male. Genitalia as in fig. 41.

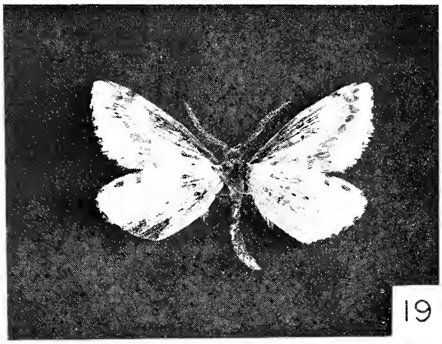
Location of type: American Museum of Natural History, New York.

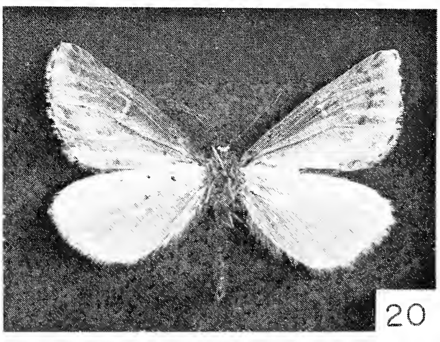
Specimens examined: ARIZONA: 27 males, 10 females, Baboquivari Mountains, Pima County, 23 April 1938 (J.A. Comstock); 49 males, 15 females, same locality as preceding, April (J.L. Sperry); 4 males, 14 females, "Bab. 4-27" (O. Buchholz Collection); 2 males, 2 females, Brown Canyon, Baboquivari Mountains, Pima County, 5 September 1953 (L.M. Martin); 1 female, same locality as preceding, 8 June 1952 (M. Cazier W. Gertsch, R. Schrammel); 3 females, Sabino Canyon, Santa Catalina Mts., Pima County, 9 April 1951 (L.M. Martin); 3 females, El Mirador Ranch, 4 miles northwest Sasabe, Baboquivari Mountains, Pima County, 3,900 feet elevation, 3 September 1950 (T. Cohn, P. Boone, M. Cazier); 2 females, Baboquivari Mountains, Pima County, 4 April 1935 (ex Guedet Coll.); 1 male, Pena Blanca Canyon, Oro Blanco Mountains, Santa Cruz County, 3 August 1960 (L.M. Martin); 1 female, Globe, Gila County, 17 July 1936; 1 female "Ariz.", ex O. Buchholz Coll. "B. & McD. locality Pima Co. Ariz. April 1-15, Coll. Samuel E. Cassino."; 1 female, no locality, "*Philtraea elegantaria* Hy. Edw., Det. Cassino."; 1 male ,"Babquiver Mts." Pima County, "Photograph pl. 20, no. 2", "*P. elegantaria* Hy. Edw. Comp. with Type Coll. Am Mus J. McD.", male genitalia slide 7 October 1939, H.W. Capps #330; 5 males, 2 females, same locality as preceding; 1 male, 9 females, Baboquivari Mountains, Pima County, 1-4 August 1923 (O.C. Poling), "Barnes Collection"; 1 male, 5 females, Sells Post Office, Indian Oasis, Pima County, 1-15 April 1923 (O.C. Poling), "Barnes Collection"; 6 females, Guadalupe Canyon, Cochise County, 31 July 1967 (C.W. Baker).


16


17


18


19


20

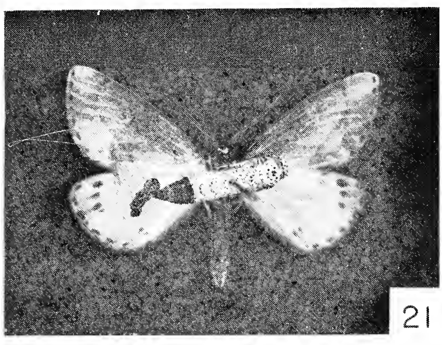

21

Fig. 16.—*P. monillata* Bkt., holotype male. MISSOURI. Barnhart, Jefferson County, 25 June 1935 (E.P. Meiners), Bauer-Buckett slide no. 66B2-23. Fig. 17.—*P. monillata*, allotype female. Same data as fig. 16. Fig. 18.—*P. monillata*, paratype male. Same locality as holotype, 26 August 1933 (E.P. Meiners). Note small size of second, or late summer, generation. Fig. 19.—*P. elegantaria*, male. Ventral surface of wings; note absense of fuscous scalation. Data same as fig. 4. Fig. 20.—*P. albimaxima*, holotype male. Ventral surface of wings; note dusky surface of primaries. Data same as fig. 12. Fig. 21.—*P. latifoliae*, holotype male. Ventral surface of wings; note deep fuscous surface of primaries. Also note pupal case with black flecks on whitish background. Data same as fig. 10.

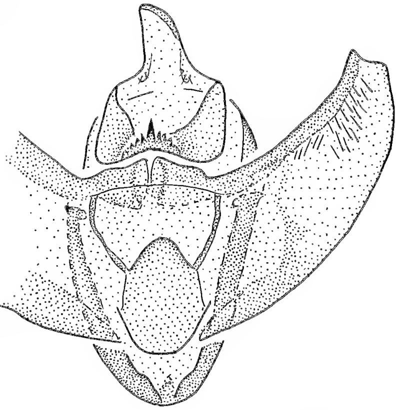
P. elegantaria can be at once separated from *utahensis,* its closest ally, by maculation of the primaries dorsally, and by the shape of the juxta in the male genitalia. The maculation of the primaries in *utahensis* lacks the series of heavy black dots tending the transverse lines, therefore the lines appear more "golden" in color (see figs. 5 and 6); whereas, in *elegantaria* there is a heavy series of black dots tending the transverse lines.

The juxta in the male genitalia of *elegantaria* is narrower and more pointed terminally (as in fig. 24) than in *utahensis,* and this characteristic will serve as of diagnostic value. The present known distribution of *elegantaria* is the southern portion of Arizona, whereas in *utahensis,* the distribution is more northerly (see distribution map, fig. 1). The ventral surface of the primaries in *elegantaria* is white, whereas in *utahensis* it is "off-white".

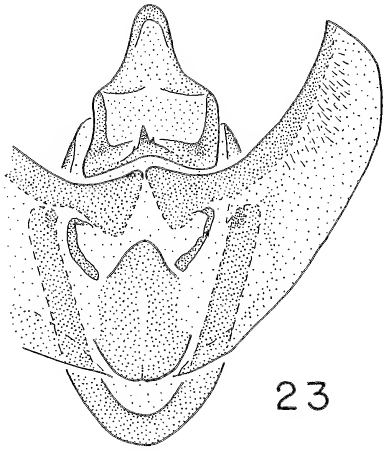
Philtraea utahensis Buckett, n. sp.

(Figs. 1, 5, 6, 22, 34, 42)

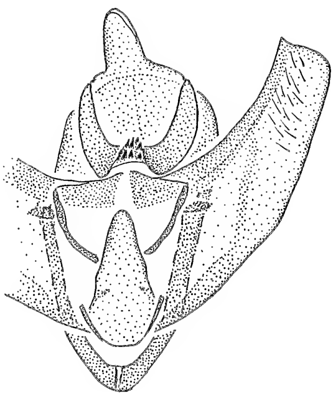
Male: Ground color of primaries white; transverse anterior and transverse posterior lines thin in comparison to *elegantaria.* Head with vertex clothed in predominence of yellow-golden elongate scales and hairs; antennae with scape and pedicel clothed in white scales, flagellum dorsally clothed in white scales, ventrally with elongate bipectinations; frons clothed in both yellow-golden and whitish elongate hairs and scales, integument evenly rounded, but with reticulations; maxillary palpi almost rudimentary, or very reduced, clothed in white hairs; proboscis very diminutive. Thorax dorsally with divided collar clothed in elongate white hairs which are terminally directed centrally; tegulae basally clothed in yellow-golden, terminally composed of elongate whitish hairs; ventrally clothed in elongate whitish hairs and scales; legs with tibiae clothed in whitish and brownish scales and hairs; tarsi clothed in white scales and hairs; primaries dorsally with ground color white; transverse anterior and transverse posterior lines thin, with much yellow, little exterolateral black coloration; "U" or "O" shaped mark between transverse anterior and transverse posterior lines possessing a transversely divided black mark; terminal line faint, represented by black dots between veins; fringes white; ventral surface slightly off-white; maculation of dorsal surface visible through ventral surface; secondaries dorsally white; terminal line faintly discernible at best, blackish; ventral surface whitish, but with terminal line more pronounced, discontinuous over its course. Abdomen as in *elegantaria.* Greatest expanse of forewing 16mm.



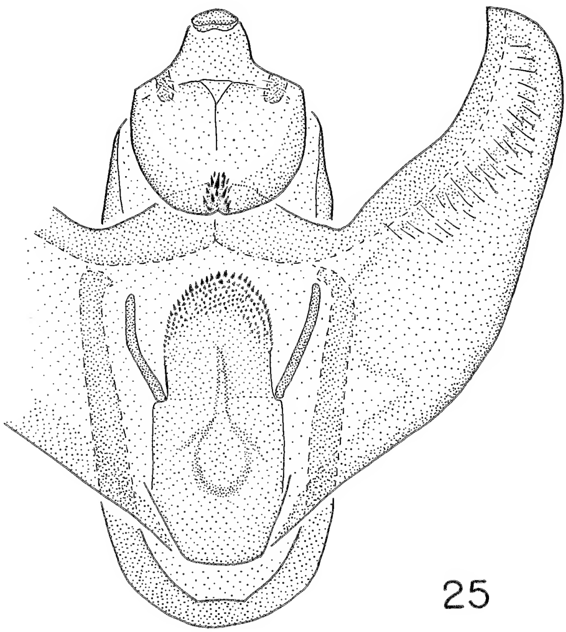
22



23



24



25

Fig. 22.—*P. utahensis*, paratype, Bauer-Buckett slide no. 66B2-22. Fig. 23.—*P. surcaliforniae*, paratype, Bauer-Buckett slide no. 67K29-23. Fig. 24.—*P. elegantaria*, homotype, Bauer-Buckett slide no. 66A31-21. Fig. 25.—*P. mexicana*, holotype, Bauer-Buckett slide no. 67D10-1. All male genitalia, minus aedeagus.

Genitalia as in figs. 22 and 34.

Female: As in male but slightly larger; antennal pectinations ± one half the length of male pectinations; primaries dorsally with transverse anterior and transverse posterior lines slightly more black than in male; terminal line more pronounced; ventral surface of primaries white; secondaries dorsally with terminal line more pronounced; ventral surface of secondaries as in dorsal surface. Abdomen as in male. Greatest expanse of forewing 17mm. Genitalia as in fig. 42.

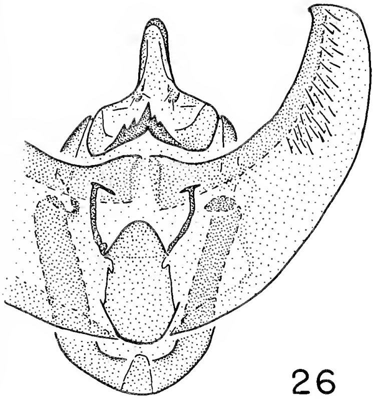
Specimens examined: UTAH: Holotype male: St. George, Washington County, June, genitalia mounted on slide no. 4615 (by F.H. Rindge), in collection American Museum of Natural History, New York. Paratypes: 1 female (designated allotype), same data as holotype. Ac. 4473; 1 male, collection of Grace H. and John L. Sperry, Moab, Grand County, 27 June 1949 (Crickmer); 1 female, collection of Grace H. and John L. Sperry, Monument Valley, San Juan County, 20 June 1949 (Crickmer); NEVADA: 1 female, Beaver Dam State Park, Lincoln County, 27 July 1967 (G.D. Cooney).

P. utahensis is most closely related to *elegantaria,* as is evidenced by the male genitalia. The juxta in *utahensis* is broader than in *elegantaria*; the maculation of the primaries is different between the species, *elegantaria* possessing much more black in the composition of the transverse anterior and transverse posterior lines; whereas, in *utahensis* this black is somewhat less, therefore giving the impression of the transverse anterior and transverse posterior lines being narrower (see figs. 5 and 6). The ventral surface of the primaries in *utahensis* is "off-white," whereas, in *elegantaria* this surface is white.

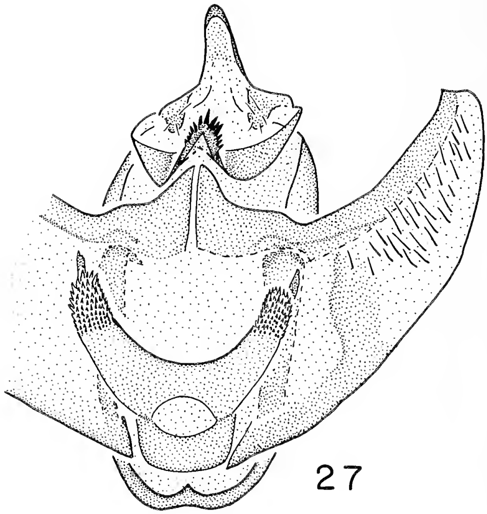
Thus far, *utahensis* has only been collected in Utah and Nevada, but with further efforts in the field, it is almost certain that additional distributional data may be obtained. Nothing is known of the immature stages of this species as far as the author can ascertain.

Philtraea surcaliforniae Buckett, n. sp.
(Figs. 2, 9, 23, 36, 43)

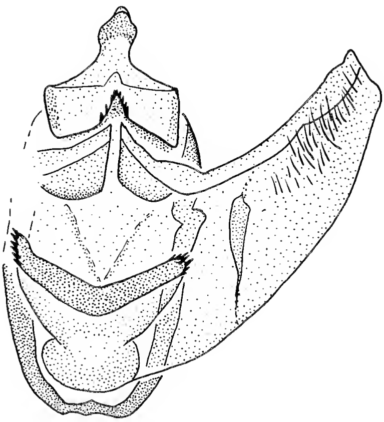
Male: Ground color of primaries white, little black associated with transverse lines; "U" shaped mark broadly open costally, Head with vertex clothed in broad, simple, yellow-golden scales; frons clothed in simple white and yellow-golden scales, integument nearly smooth; antennae with scape and pedicel clothed in white scales; flagellum dorsally clothed in white scales, bipectinate beneath, pectinations being ±5X the flagellomere length at central portion of antennae; basal pectinations and terminal pectinations of lesser length; maxillary palpi small, but protruding well beyond region of anterior tentorial pits;



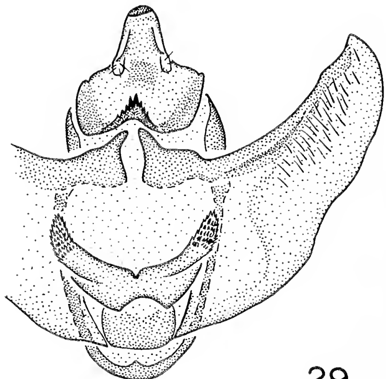
26



27



28



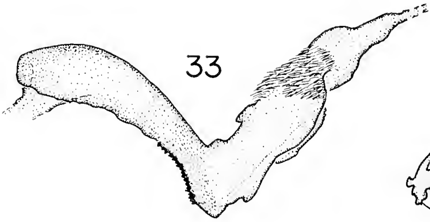
29

Fig. 26.—*P. latifoliae,* holotype, Bauer-Buckett slide no. 67K29-21. Fig. 27.—*P. albimaxima,* paratype, Bauer-Buckett slide no. 66B3-33. Fig. 28.—*P. paucimacula,* Bauer-Buckett slide no. 67D11-21. Fig. 29.—*P. paucimacula,* Bauer-Buckett slide no. 66B3-24. Note variation between this specimen and fig. 28. Both specimens from New Mexico. All male genitalia, minus aedeagus.

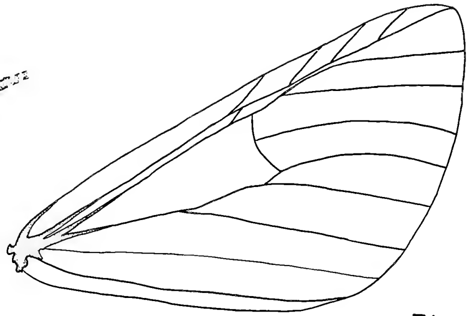
proboscis apparently vestigial. Thorax dorsally with divided collar composed of elongate white hairs and scales, hairs terminally centrally directed toward midline; tegulae prominently yellow-golden laterally, composed of elongate scales, inwardly composed of elongate white hairs; disc clothed in minute white scales and sparsity of elongate white hairs; ventrally clothed in white scales and elongate white hairs; legs clothed in white scales; tibial end spurs clothed in brown hairs; primaries dorsally with ground color white; transverse anterior and transverse posterior lines broadly spaced on inner margin, coloration predominently yellow, very little black; "U" shaped mark broadly open on costa; terminal line represented by dashes between veins; fringes white; ventral surface white, maculation of dorsal surface being plainly seen when observing ventral surface; secondaries dorsally white, slight suggestion of terminal line, fringes white; ventral surface white; terminal line prominent; black dot present at wing apex. Abdomen clothed dorsally and ventrally in white scales and sparsity of white hairs. Greatest expanse of forewing 20mm. Genitalia as in figs. 23 and 36.

Female: As in male except for antennal bipectinations which are ±2X flagellomere length at central portion of antennae. Greatest expanse of forewing ±20mm. Genitalia as in fig. 43.
expanse of forewing ±20mm. Genitalia as in fig. 43.

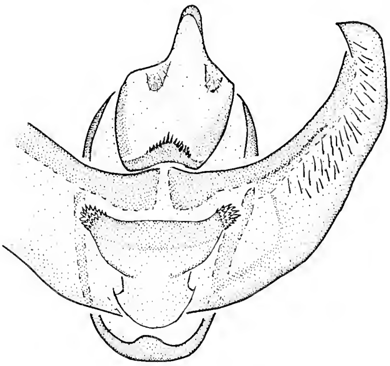
Specimens examined: CALIFORNIA: Holotype male: Howard Creek, Ventura County, 15 July 1967 (P.M. Jump), in Type Collection, Department of Entomology, University of California, Davis, California. Paratypes: 1 female (designated allotype), San Marcos Pass, north of Santa Barbara, Santa Barbara County, 4 July 1965 (J.S. Buckett); 1 femle, same data as in preceding; 2 females, same locality as preceding, 4 and 7 July 1965 (J.A. Powell); 2 females, Ojai, Ventura County, 15 July 1940; 1 female, same locality as preceding, 15 July 1963 (W.E. Simonds); 1 female, Bouquet Canyon, Los Angeles County, 2,800 feet elevation, 14 June 1946 (C. Henne); 1 female, Santa Barbara, Santa Barbara County, 25 August 1966 (R. Young); 2 females, Summerland, Santa Barbara County, 19 June and 1 July 1949, (C.W. Kirkwood); 1 female, Santa Barbara, Santa Barbara County, 27 June 1938 (C.W. Kirkwood); 1 female, Jucumba, San Diego County, 24 May 1921; 1 female, Wheeler's, Ventura County, 13 July (P.M. Jump); Mint Canyon, Los Angeles County, 10 June 1950 (C. Hill), in collection of Grace H. and John L. Sperry; 1 female, Murrieta, Riverside County, 1 June 1939 (J. von Bloeker), (Bauer-Buckett slide no. 66B4-22); 2 females, Ventura, Ventura County, 22 June 1949 (C.W. Kirkwood); 3 females, San Louis Obispo County, with label affixed "Through C.V. Riley"; 1 male, 13 females, Howard Creek, Ventura County, 17 June 1965 (P.M. Jump); 11 males, 30 females, same locality and collector as in preceding, 15 July 1967; 1 female, Ojai, Ventura County, 21 June 1960 (P.M. Jump). Additional specimens: MEXICO: 1 male, Guaycura Hotel grounds, La Paz, Baja California, Sur, 2 December 1961, Cary-Carnegie Expedition, C.M. Acc. 20082, (genitalia on slide, F.H. Rindge no. 12,595).



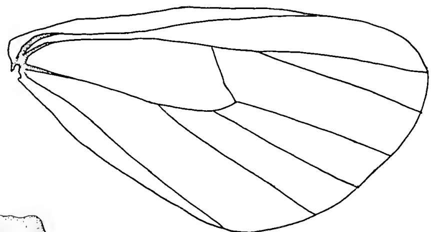
33



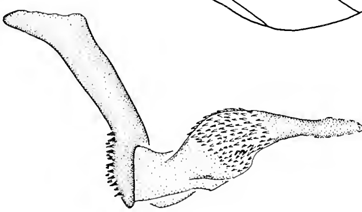
31



30



32



34

Fig. 30.—*P. monillata*, paratype, Bauer-Buckett slide no. 66B-2-23. Male genitalia, minus aedeagus.

Fig. 31.—*P. elegantaria*, venation of right forewing. Slide from American Museum of Natural History bearing no. 5103.

Fig. 32.—*P. elegantaria*, venation of right hindwing. Data same as fig. 31.

Fig. 33—*P. elegantaria*, Bauer-Buckett slide no. 67D10-23. Aedeagus of male genitalia inflated.

Fig. 34—*P. utahensis*, paratype, Bauer-Buckett slide no. 66B2-22. Aedeagus of male genitalia inflated.

P. surcaliforniae is a large species, thus far known only from southern California, and from 1 male specimen taken in Baja California, Sur, Mexico. It may be distinguished from *mexicana* by the lack of prominent black marks tending the transverse lines on the primaries. From *latifoliae, surcaliforniae* may be distinguished by the absence of the deep fuscous coloration on the ventral surface of the primaries in the male. At this time, it is difficult to compare females of *surcaliforniae* and *latifoliae*, because the two female specimens of the latter species are in poor condition. By male genitalia, *surcaliforniae* differs from *latifoliae* by the former possessing more sclerotized genitalia in general; broader uncus; more rectangular, apically pointed juxta (rather than subconical); larger aedeagus; more heavily spinose vesical sac.

Thus far, in the larval stage, *surcaliforniae* is known to feed on *Fraxinus dipetala* H. & A. (flowering ash). Comstock (1934), under the species heading "*elegantaria*" records the following for *surcaliforniae*: "On June 17, 1933 while beating *Ceanothus* bushes in Bouquet Canyon for larva, a single chrysalis was secured, which, on June 23, gave forth an imago. This proved to be a female, and fortunately produced a few eggs while on the setting block. These were, of course, infertile, and it was therefore impossible to record the larva." He further states of the immature stages: "Egg. Size .75mm. tall x .5mm. thick. Color, opaque light green. In form it is sub-ovoid, with a rounded base and strongly cupped top. The surface is smooth, except for the micropylar end, which is finely granular. . . . Pupa. Length, 13mm. Greatest width through 3rd abdominal segment, 3.2mm. Color, lemon-yellow, with numerous black markings, disposed as shown in illustration. Antennal cases black."

It is interesting to note that the "lemon-yellow" ground color of the pupa is slightly different than the color for the pupa of *latifoliae*. The coloration of the pupa may serve as a distinguishing factor between the two California species. In addition, the presently known distribution limits *surcaliforniae* to southern California (see distribution map, fig. 2), on into Baja California, Sur, Mexico.

Philtraea latifoliae Buckett, n. sp.
(Figs. 2, 10, 11, 21, 26, 35, 44, 49-52)

Male: Ground color of primaries dorsally white, ventrally deep fuscous, transverse lines thin, with much yellow and black, maculation prominent. Head with vertex clothed in deep brilliant gold scales and hairs; frons clothed dorsad in whitish

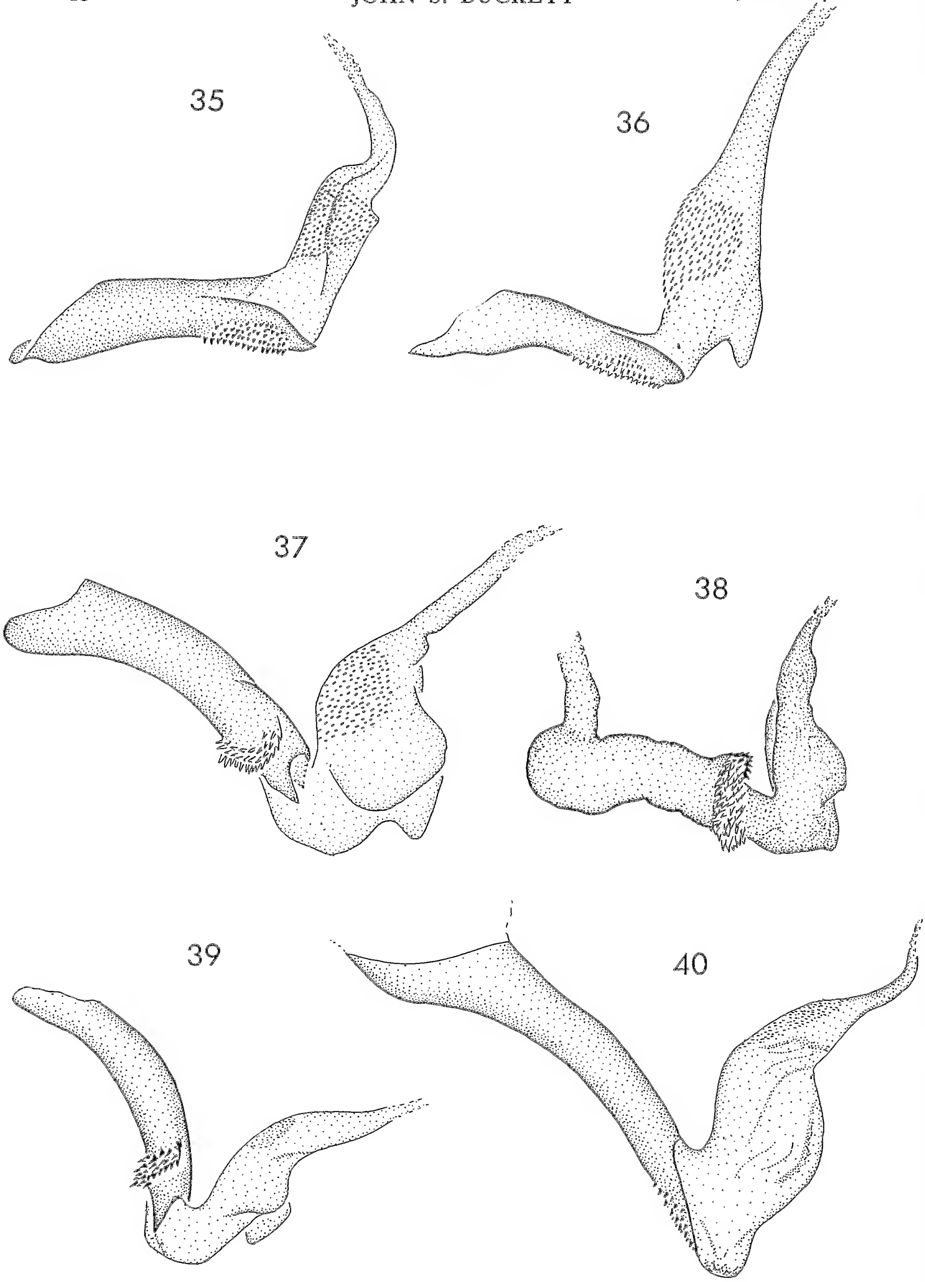


Fig. 35.—*P. latifoliae*, holotype, data same as fig. 26. Fig. 36.—*P. surcaliforniae*, paratype, data same as fig. 23. Fig. 37.—*P. albimaxima*, paratype, data same as fig. 27. Fig. 38.—*P. paucimácula*, Bauer-Buckett slide no. 67D10-22. Fig. 39.—*P. monillata*, paratype, data same as fig. 30. Fig. 40.—*P. mexicana*, holotype, data same as fig. 25. All aedeagi of male genitalia inflated.

scales and hairs, remainder clothed as in vertex; maxillary palpi short, clothed exterolaterally in fuscous; proboscis very diminutive, appearing as though wanting; antennae with scape and pedicel clothed in snow-white broad scales; flagellomeres dorsally clothed in snow-white scales to terminal end, ventrally with bipectinations very long. Thorax with collar white, composed of elongate scales and hairs; tegulae clothed in very elongate thin hairs, basally brilliant golden, terminal two-thirds white; disc clothed in white hairs and few white scales; ventrally clothed in elongate fuscous hairs; legs dark exterolaterally, clothed predominently in elongate hairs, also few dark scales; primaries dorsally with ground color pure white; costa clothed in golden scales basally to transverse anterior line, the only interruption being a black dot where basal line would commence; transverse anterior line represented costally in black, thence golden, bordered by black dots between veins, from costa outcurving medially, thence toward base, thence outward to inner margin; "U" shaped mark of median area open costally, colored as in transverse anterior line; transverse posterior line colored as in transverse anterior line, thinnest medially; terminal line represented as black lunules between veins; fringes off-white; ventral surface deep smokey fuscous, but maculation of dorsal surface visible through wing; secondaries dorsally white with exterior line represented by black dots (as in fig. 10); terminal line represented by black lunules between veins; fringes off-white; ventral surface marked as in dorsal surface, but with darker ground color. Abdomen clothed in elongate white hairs and scales both dorsally and ventrally. Greatest expanse of forewing 17mm. Genitalia as in figs. 26 and 35.

Female: Lighter than in male, maculation less prominent; secondaries lacking exterior line as in male; ventral surface much lighter in color than in male, but with taint of fuscous. Greatest expanse of forewing 18mm. Genitalia as in fig. 44.

Specimens examined: CALIFORNIA: Holotype male: 8+ miles west of Winters, in Solano County, 8 May 1964, ex *Fraxinus latifolia* (Oregon ash), McFarland larval no. G.56 (A.N. McFarland, J.S. Buckett & M.R. Gardner), Bauer-Buckett slide no. 67K29-21, (in type collection, Entomology Department, University of California, Davis. Paratypes: 1 female (designated allotype), Vacaville, Solano County, 13 July 1948 (A.T. McClay), Bauer-Buckett slide no. 66B6-21; 1 female, 3.5 miles northwest of Rumsey, Yolo County, 30 June 1967, 10:30 PM, light trap (R.F. Denno).

Mature larva: Head ±1.8mm broad; maculation and chaetotaxy of head, thorax and abdomen as illustrated (see figs. 49, 50, 51 and 52), ground color creamy-white. Total length of inflated

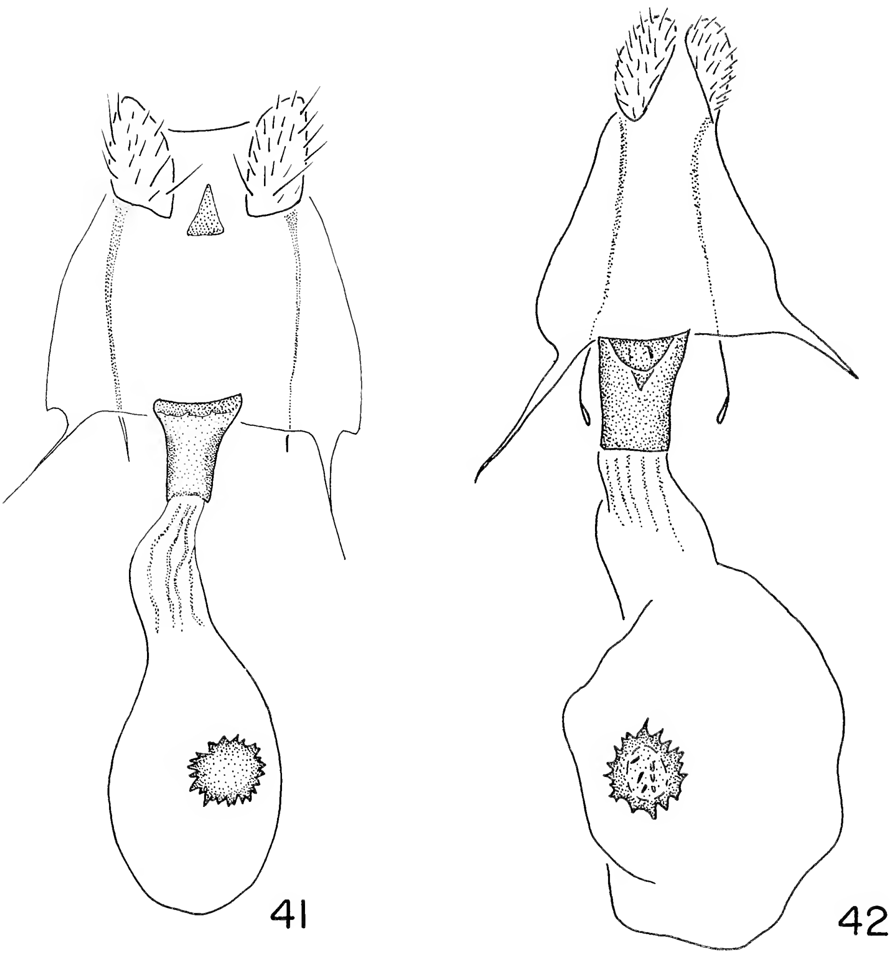


Fig. 41.—*P. elegantaria,* Bauer-Buckett slide no. 66B3-35. Fig. 42.—*P. utahensis,* paratype, Bauer-Buckett slide no. 68J30-2. Female genitalia.

larva [preserved in KASA = 3 parts, Kerosene; 9 parts, 95% ethyl alcohol; 5 parts, sec-butyl alcohol; 2 parts, glacial acetic acid, and later transferred to 100% ethanol] ±28mm.

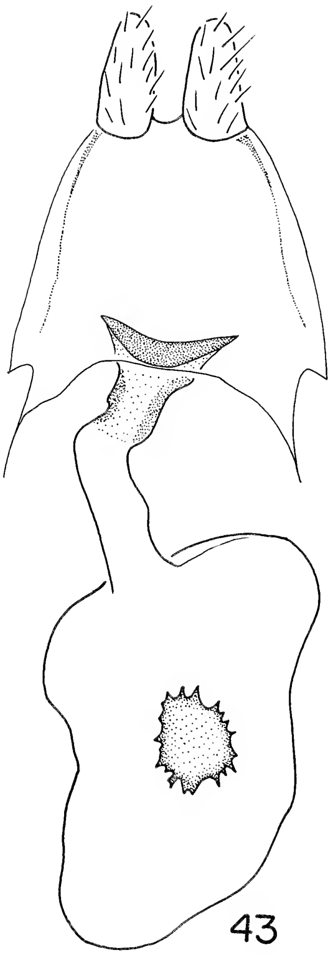
Ground color dorsally light grey, integument slightly glossy, ventrally paler, a whitish-grey. Subdorsal yellow spots present, one pair per segment, as well as a similar series of subspiracular yellow-orange dots; also similar, but fainter dots on venter of abdominal segments 1 through 5 and on venter of abdominal segment 7. Body strongly marked with small, black setigerous tubercles; also possessing very fine, narrow, transverse lines on dorsal and lateral areas; prolegs of sixth abdominal segment with triordinal crochets, a homoideous mesoseries; anal prolegs with triordinal crochets, an interrupted mesoseries.

General outline peculiar in that it becomes posteriorly enlarged, thickest in abdominal segments 4, 5 and 6 than elsewhere.

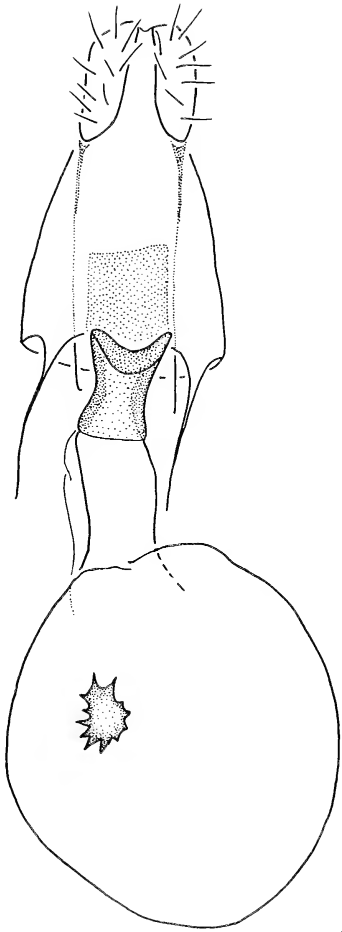
If handled, larva will fold up and fall over on its side, remaining quiescent for many minutes; larva assumes a "fish-hook" position when feigning death. When the host plant is beaten or shaken, the larvae will drop on tough silken strands, rendering them quite easily attainable to the collector.

Host plant: Fraxinus latifolia Benth. (Oregon ash), as far as is known. Many larvae collected 8 May 1964 at the type locality (A.N. McFarland, J.S. Buckett and M.R. Gardner).

Pupa: (see fig. 21). Extremely colorful. Head very bright yellow; a black crescent present over part of each compound eye; antennal cases brown, speckled with black laterally. Thorax yellowish-grey, dotted with black; wing cases bright deep yellow, speckled with black in a small area near middle of costal margin, also marked with black along the outer margin and at inner angle; area of legs pale yellow-grey with scattered black dots present also. Abdomen with ground color light grey; two subdorsal rows composed of deep yellow spots present (in some pupae, the yellow coloration of the abdomen is not well defined into spots, but is more generally distributed on the dorsum); black tubercles present all over abdomen also; cremaster black. Pupa capable of lively, circular abdominal movement. It is found in a weak "cocoon" or open "net", suspended in the air between two or more leaves, or in somewhat a protected place. Pupa easily seen through the *very* open net of colorless silk.



43



44

Fig. 43.—*P. surcaliforniae,* paratype, Bauer-Buckett slide no. 66B4-21. Fig. 44.—*P. latifoliae,* paratype, Bauer-Buckett slide no. 68I19-1. Female genitalia.

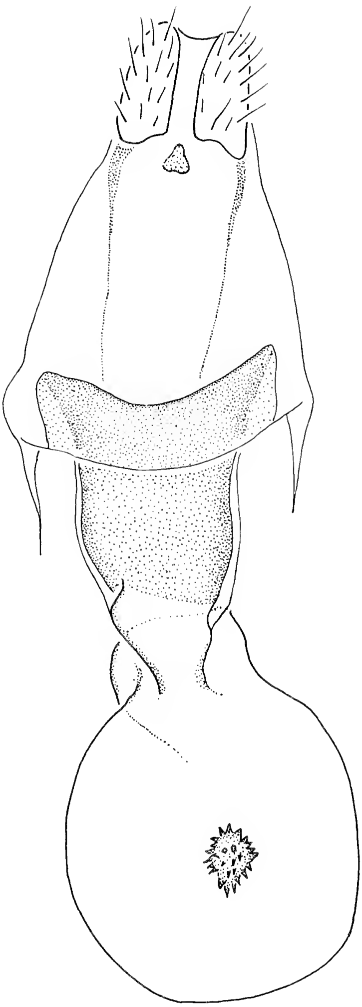
The above larval and pupal descriptions were drawn from and slightly modified from notes taken of living specimens by my good friend and colleague Mr. A. Noel McFarland. For use of these notes (McFarland No. G.56) I am greatly indebted.

P. latifoliae is most closely related to *P. albimaxima* in the male by the fuscous ventral surface of the primaries. By male genitalia, *latifoliae* is most closely related to *surcaliforniae*; however, in the former species, the genitalia is less sclerotized; juxta subconical (rather than nearly rectangular as in *surcaliforniae*); smaller aedeagus; lightly spinose vesical sac. In addition, the known range of *latifoliae* is Yolo and Solano Counties, far to the north of the range of other species within the genus (see distribution map, fig. 2). Along with *elegantaria, utahensis,* and *surcaliforniae, latifoliae* is placed in the *elegantaria* species group.

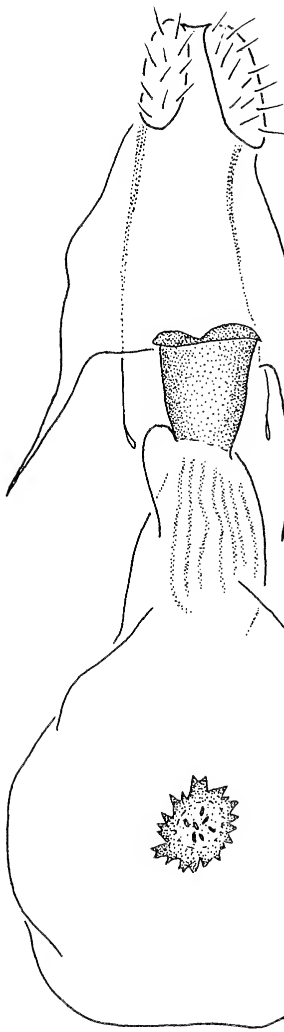
Philtraea mexicana Buckett, n. sp.

(Figs. 3, 7, 8, 25, 40, 45)

Male: Lacks antennae and is somewhat worn, but was the only male of the species present at the time of description. Ground color of primaries whitish, transverse lines broad, possessing much black. Head with vertex and frons clothed in white scales; integument of frons slightly roughened; palpi and proboscis as for other members of the genus, but the latter somewhat better developed than in *elegantaria*. Thorax with collar somewhat damaged, but remaining vestiture composed of white scales and white elongate hairs; tegulae with suggestion of pale yellow hairs in addition to white scales and white elongate hairs; ventrally clothed in whitish hairs and scales; legs normal (metathoracic legs absent, due to breakage); primaries dorsally whitish; transverse anterior and transverse posterior lines broad, centrally filled with much yellow, exterolaterally with much black (see fig. 7); "U" shaped mark open on costa between transverse anterior and transverse posterior lines, almost connecting with transverse posterior line; terminal line represented by black lunules between veins; fringes white; ventral surface just off white in coloration; dorsal maculation clearly visible through ventral surface; secondaries dorsally whitish; slight suggestion of fringe, in black; ventral surface as in dorsal surface but veins faintly outlined in fuscous terminally. Abdomen clothed predominently in white scales and elongate hairs. Greatest expanse of forewing 21mm. Genitalia as in figs. 25 and 40.



45



46

Fig. 45.—*P. mexicana*, paratype, Bauer-Buckett slide no. 67D11-24. Fig. 46.—*P. albimaxima*, allotype, Bauer-Buckett slide no. 68J30-1. Female genitalia.

Female: As in male but smaller, pectinations of antennae small; dorsal surface of antennae clothed in white scales; tegulae whitish; primaries lacking prominent yellow centrally in transverse anterior and transverse posterior lines, as well as in "U" shaped mark; otherwise as in male. Greatest expanse of forewing 18mm (see fig. 8). Genitalia as in fig. 45.

Specimens examined: MEXICO: Holotype male: "Mexico", with no further locality data, (R. Muller), Bauer-Buckett slide no. 67D10-21 (in collection of United States National Museum). Paratypes: 1 female (designated allotype), 3 miles east of Galeana, Nuevo Leon, 5,000 feet elevation, 7-9 August 1963 (W.D. Duckworth and D.R. Davis); 4 females, same data as in preceding; 1 female, Bahia de Palmas, Baja California, Sur, 2 November 1961, Cary-Carnegie Expedition 1961, C.M. Acc. 20082; 1 female, Rancho San Bernardino, Sierra Laguna, Baja California, 2 November 1961, same expedition and number as preceding, Bauer-Buckett slide no. 66B4-23; 1 female, A. San Bartolo, Baja California, Sur, 2 November 1961, same expedition and number as preceding; 3 females, Ridge northwest of Jocoque Dam, Aguascalientes, 19 August 1960 (P.H. Arnaud, Jr., E.S. Ross, and D.C. Rentz); 1 female, Actopan, Coll. C.C. Hoffmann, Cat. No. 2855 (genitalia on slide F.H. Rindge, No. 4628); 1 male, Creel, Chihuahua, 14 July 1968, 7,500 feet elevation (T.A. Sears and R.C. Gardner).

P. mexicana is a large species which possesses a considerable amount of black tending the transverse cross lines on the dorsal surface of the primaries. This characteristic is unlike *surcaliforniae* and *albimaxima* with which it might be confused due to the large size of specimens of the three species concerned. Also in the male genitalia, heavy sclerotization and the shape of the juxta (see fig. 25) will serve to distinguish *mexicana* from related entities. By the female genitalia, the heavily sclerotized trapazoidal ductus antivaginalis will serve as a diagnostic character.

I herein consider *mexicana* as representing a monotypic species group and it appears to apparently be intermediate between the *paucimacula* group and the *elegantaria* group. The presently known distribution of *mexicana* encompasses central Mexico and Baja California, Sur, Mexico (see distribution map, fig. 3).

Philtraea albimaxima Buckett, n. sp.

(Figs. 1, 12, 13, 20, 27, 37, 46)

Male: Ground color of primaries a glistening white, maculation not too prominent. Head with vertex and frons clothed in pale yellow scales and hairs; integument of frons evenly rounded, rather flat, reticulate over its surface; antennae with scape and pedicel clothed in white scales; flagellum dorsally clothed in

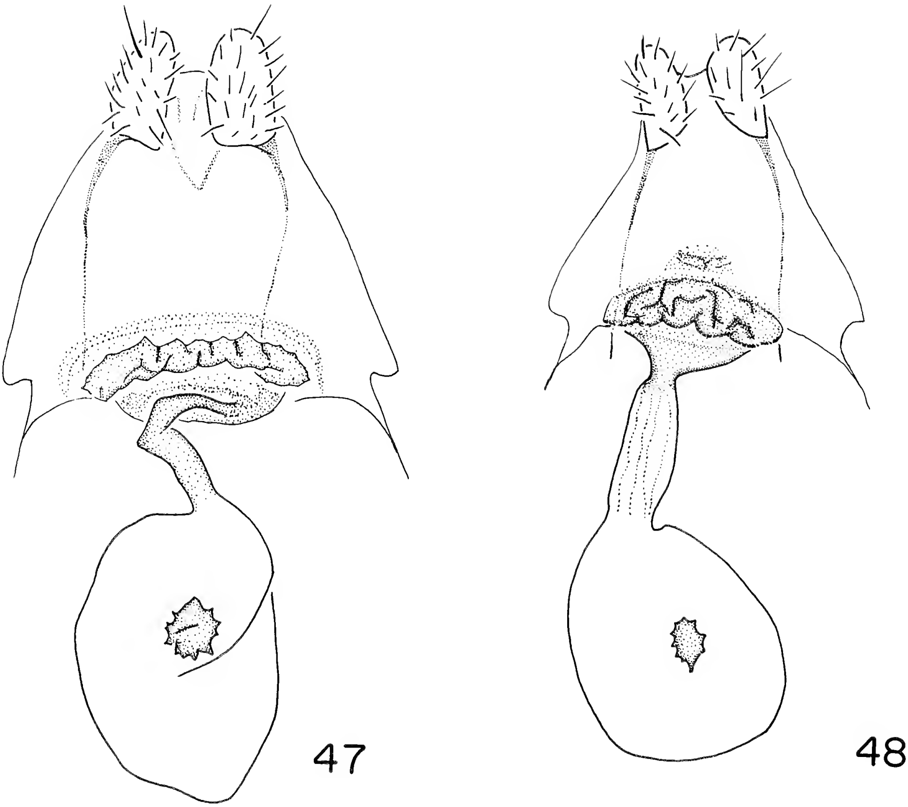


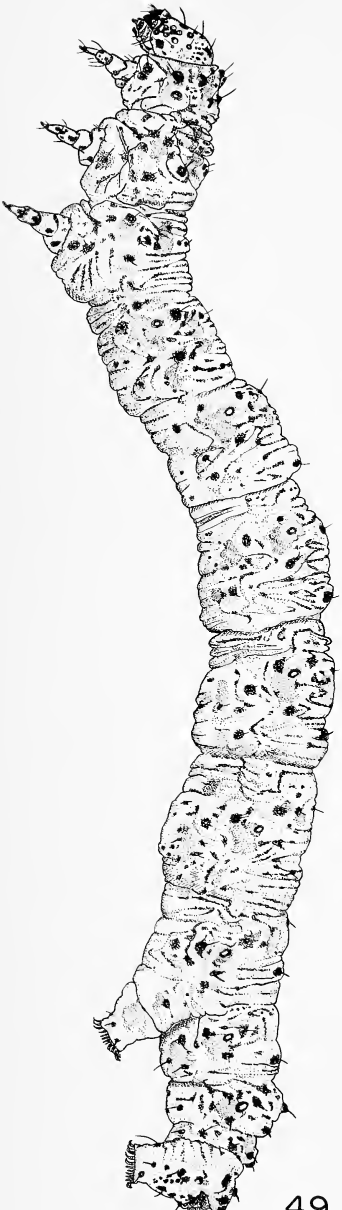
Fig. 47.—*P. paucimacula,* Bauer-Buckett slide no. 66B3-32. Fig. 48—*P. monillata,* paratype, Bauer-Buckett slide no 66B3-23. Female genitalia.

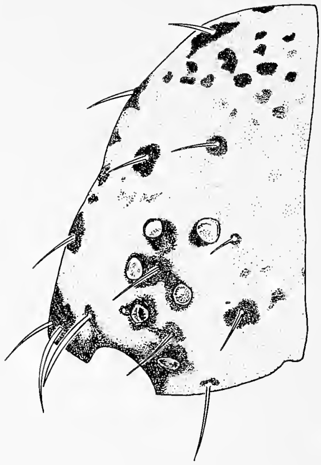
white scales; ventrally, bipectinations extremely long; maxillary palpi protruding beyond region of anterior tentorial pits, clothed in white elongate hairs, terminal segment black-tipped; proboscis small. Thorax dorsally with divided collar basally yellow, thence composed of elongate white hairs; tegulae basally clothed in yellow-golden scales and hairs, medially and terminally composed of elongate white hairs; disc clothed in small white scales and sparsity of white hairs; legs with femora and tibiae dorsally clothed in brown scales, ventrally clothed in white scales; protarsi dorsally clothed in white scales, ventrally in brown; meso and metatarsi clothed dorsally in brown, ventrally in white; primaries dorsally a glistening white, transverse anterior line geminate, outer thin bands represented by black dots between veins, central portion faint, light yellow; "U" shaped mark open on costa, colored as in transverse anterior line; transverse posterior line represented from costa to Cu_2 merely as a geminate line of black dots, central color white, from Cu_2 to inner margin, transverse posterior line colored as in transverse anterior line; terminal line represented as black dashes between veins; fringes white; ventral surface conspicuously dusky, veins darker; dorsal maculation seen through ventral surface; fringes white; secondaries dorsally white; slight suggestion of terminal line; fringes white; ventral surface as in dorsal surface. Abdomen dorsally and ventrally clothed in white scales and sparsity of white hairs. Greatest expanse of forewing 20mm. Genitalia as in figs. 27 and 37.

Female: Similar to male except for antennal ciliations which are shorter; transverse lines somewhat more prominent; ventral surface of primaries white. Greatest expanse of forewing 20-21mm. Genitalia as in fig. 46.

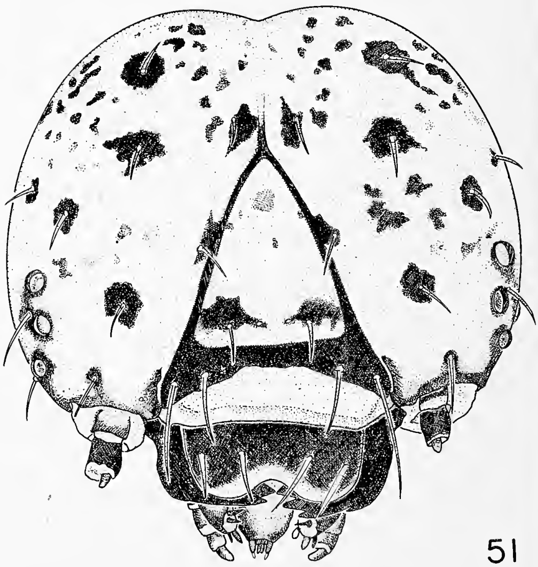
Specimens examined: ARIZONA: Holotype male: Oak Creek Canyon, 15 miles north of Sedona, Coconino County, 5,000 feet elevation, collected at 6:15 AM, 21 July 1965 (F. Thorne), (in collection of the Los Angeles County Museum of Natural History, Los Angeles, California). Paratypes: 1 female (designated allotype), 7 miles west of Williams, Coconino County, 23-28 July 1957 (A.N. McFarland); 1 male, same locality and collector as holotype, Bauer-Buckett slide no. 66B3-33; 6 males same locality and collector as preceding; 4 males, collection of Grace H. and John L. Sperry, Todd's Lodge, Oak Creek Canyon, Coconino County, 16-18 June 1946, (1 male bearing Bauer-Buckett slide no. 66B3-34).

P. albimaxima is, perhaps, one of the least striking of the *Philtraea* in that it lacks prominent transverse crosslines on the dorsal surface of the primaries. In addition, in the male, the ventral surface of the primaries is fuscous rather than white, or "off-white", as is found in other species of the *paucimacula* group. *P. albimaxima* is one of the most distinct species in the genus, and when considering a combination of characters, can-





50



49

51

Fig. 49.—*P. latifoliae*, ultimate instar larva, laterial view. Fig. 50.—*P. latifoliae*, head, laterial view. Fig. 51.—*P. latifoliae*, head, frontal view. All CALIFORNIA: 8+ miles west of Winters, in Solano County, 8 May 1964 (A.N. McFarland, J.S. Buckett and M.R. Gardner).

not be confused with any other species within the genus.

As mentioned for *latifoliae, albimaxima* is the only other species in which the male possesses the fuscous ventral surface of the primaries. The male genitalia are typical for the *paucimacula* group as herein conceived (see figs. 27 and 37).

Thus far, *albimaxima* is only found in and adjacent to the Oak Creek Canyon, Arizona. Nothing is yet known concerning the immature stages of this species.

Philtraea paucimacula Barnes and McDunnough
(Figs. 3, 14, 15, 28, 29, 38, 47)

Male: Ground color of primaries white both dorsally and ventrally, transverse lines thin, with much yellow, or maculation may be lacking. Head with vertex clothed in yellowish to yellowish-golden scales and hairs; frons clothed in white, yellow scales and hairs; integument roughened, granulated; maxillary palpi small, not extending beyond area of anterior tentorial pits, clothed in white scales and elongate hairs ventrally; proboscis diminutive; antennae with scape and pedicel clothed in white scales; flagellomeres dorsally clothed in white scales, ventrally bipectinate. Thorax with divided collar composed of white elongate hairs and scales; tegulae clothed basally in yellow scales and hairs; terminally clothed in elongate white hairs; disc clothed in small white scales; ventrally clothed in elongate white hairs and scales; legs clothed predominently in white hairs, but white scales also present; primaries with ground color of dorsal surface white; transverse lines from wanting to strongly represented in yellow, very little black bordering lines; transverse anterior line thin, yellow, exterolaterally bordered with diminutive black dots between veins; "O" or "U" shaped mark colored as in transverse anterior line, when discernible, equally removed from both transverse anterior and transverse posterior lines; transverse posterior line as in transverse anterior line, but outermost or terminal row of black dots less obvious than innermost row; terminal line represented by black dots between veins; fringes white; ventral surface white, maculation of dorsal surface visible through ventral surface when present; secondaries dorsally white, no maculation present; ventral surface as in dorsal surface. Abdomen clothed in white scales and sparsity of elongate white hairs. Greatest expanse of forewing from 12-16mm. Genitalia as in figs. 28, 29 and 38.

Female: As in male, but may be of duller coloration. Antennal bipectinations shorter than in male. Greatest expanse of forewing from 13-18mm. Genitalia as in fig. 47.

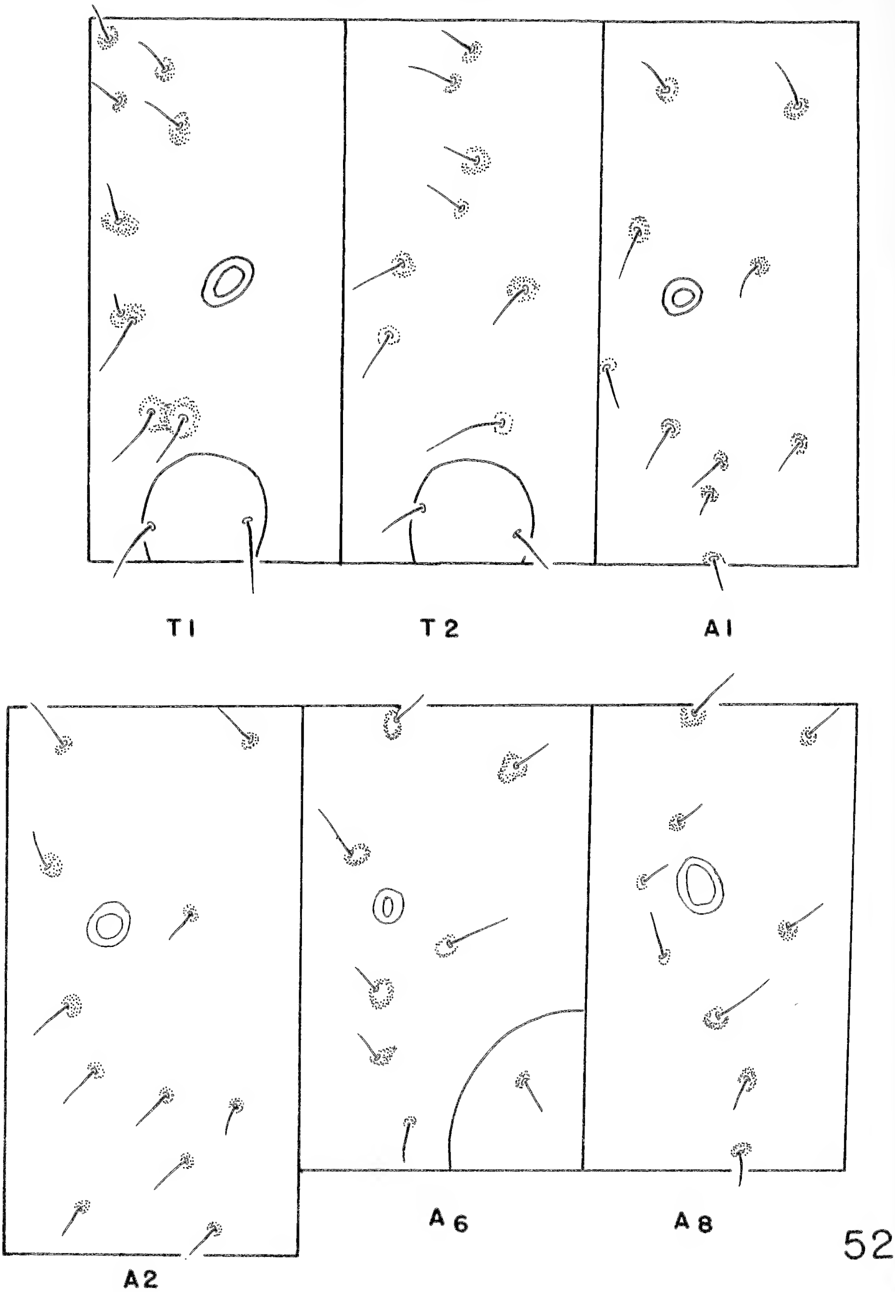


Fig. 52.—*P. latifoliae*, chaetotaxy of ultimate instar larva. T_1 and T_2 = Thoracic segments 1 and 2 respectively; A_1, A_2, A_6, and A_8 = Abdominal segments 1, 2, 6, and 8, respectively. Collection data same as fig. 49.

Specimens examined: TEXAS: Paratypes: 1 female, San Benito, Cameron County, 16-23 March, "Photograph pl. 20 No. 3"; 1 male, same locality and collection data as preceding, genitalia mounted on Bauer-Buckett slide no. 67D10-22 (in collection United States Nat. Mus.); 5 females, same locality and collection date as preceding. Additional Specimens: 3 males, 8 females, Alpine, Brewster County, April, (O. Buchholz Collection); 1 male, same locality and collection as preceding, May; 1 female, Big Bend National Park, Brewster County, 27 May 1952, 4,000 feet elevation (M. Cazier, W. Gertsch and R. Schrammel); 1 female, Big Bend National Park, Basin, 30 August 1964 (A. & M.E. Blanchard); 1 male, 2 females, same locality as preceding, 5 October 1956, (J.W. MacSwain); 2 males, Davis Mountains, Jeff Davis County, July, 1928 (O. Buchholz Collection); 1 male, same locality and date as preceding, det. Barnes and McDunnough, (Guedet Collection); 4 males, 2 females, Corpus Christi, Nueces County, 11 April 1907, "on weeds", (C.S. Spooner); 1 female, Sanderson, Terrell County, 1 April 1953 (O. Buchholz). NEW MEXICO: 3 females, Fort Wingate, McKinley County, 8-15 July (Barnes Collection); 2 males, 8 females, same locality as preceding, 1 July (J.A. Grossbeck Collection); 3 males same locality and collection as preceding, 29 June; 1 male, 1 female, same locality and collection as preceding, 10-11 July; 1 male, Jemez Springs, Sandoval County, 17 June 1916, (Barnes Collection), Bauer-Buckett slide no. 67D11-21 (in collection United States Nat. Mus.); 19 males, 9 females, Frijoles Canyon, 20 June 1942, (Collection of Grace H. and John L. Sperry). ARIZONA: 2 males, 1 female, Gila County, June, 1902 (O.C. Poling); 1 female, Hualapai Mountains, Mohave County, 15 July 1936, (Bauer-Buckett Collection); 6 females, Jerome, Yavapai County, 24 June 1901, Ac. 4473, (J.A. Grossbeck Collection); 1 male, 1 female, Prescott, Yavapai County, 1-7 July (Barnes Collection); 2 males, 2 females, same locality as preceding, 5,400 feet elevation, 15-19 June 1951 (R.F. Sternitzky); 1 male, Oak Creek Canyon, 24 June 1942, (O. Buchholz Collection); 2 females, White Mountains, (Barnes Collection); 2 males, southern Arizona, (O.C. Poling), (Barnes Collection). MEXICO: 1 female, 20 miles south Sabinas Hidalgo, Nuevo Leon, 7 July 1966 (J.S. Buckett, M.R. and R.C. Gardner); 1 female, San Juan del Rio, Durango, 5,200 feet elevation, 1 August 1957 (W. Gertsch and M. Cazier); 1 male, Salaices, Chihuahua, 23 July 1947 (W. Gertsch and M. Cazier); 1 female, 63 miles west of Santa Barbara, Chihuahua, 5,500 feet elevation, 20 July 1947, (W. Gertsch and M. Cazier).

Larval stage: Unknown.

Larval hostplants: Affixed to each of three specimens is a label which reads "on weeds."

P. paucimacula appears to be most closely related to *monillata,* from which it can be readily separated by the much narrower transverse lines of the dorsal surface of the primaries (see figs. 14 and 15), and more widespread westerly distribution. In addition, the univoltine habit of *paucimacula,* too, shows it to be different ecologically from the bivoltine *monillata* (however, a few specimens of *paucimacula* were collected in late summer).

By male genitalia, it is more difficult to distinguish between *paucimacula* and *monillata.* In the male of *paucimacula,* the lateral projections of the juxta are more pointed, and more heavily spinose; the costal undulation between the laterial pro-

jections of the juxta is not slightly raised medially. In general, the male genitalia of *paucimacula* is more heavily sclerotized, and the aedeagus is larger and more spinose at the base of the vesical sac than in *monillata* (see figs. 38 and 39).

Philtraea monillata Buckett, n. sp.
(Figs. 3, 16, 17, 18, 30, 39, 48)

Male: Ground color of primaries dorsally white, transverse lines broad, with much yellow, ventrally silghtly off-white. Head with vertex clothed in golden scales and hairs; frons clothed in ochreous-golden scales and hairs; maxillary palpi small, extending to area of anterior tentorial pits, clothed in whitish scales and hairs basally, terminal segment dusky exterolaterally; proboscis very diminutive; antennae with scape and pedicel clothed in white scales, flagellomeres clothed dorsally in white scales, ventrally bipectinate. Thorax with divided collar composed of ochreous elongate hairs and scales, vestiture longest laterally; disc clothed in white scales and hairs; these being easily rubbed off; ventrally clothed in elongate hairs and scales; legs sparsely clothed in white hairs and scales; primaries dorsally with ground color white; transverse lines very broad, represented in yellow, very little to medium amount of dark brown tending lines (as in figs. 16 and 17); transverse anterior line broad, represented costally by two dark brown dots, thence outwardly curving at region of Cu veins and onto inner margin, where line takes an outward jut, outward margin of line composed of dark brown dots between veins; "O" shaped mark colored as in transverse anterior line, equally removed from both transverse lines; transverse posterior line colored as in transverse anterior line, but not taking the outward jut as does transverse anterior line; terminal line represented by dark brown sub-lunules between veins; fringes white; ventral surface off-white, dorsal maculation being visible through surface; secondaries white both dorsally and ventrally. Abdomen clothed dorsally and ventrally in white scales and hairs. Greatest expanse of forewing 15mm. Genitalia as in figs. 30 and 39.

Female: As in male, but with shorter bipectinations than in male; also transverse posterior line on dorsal surface of primaries somewhat narrower; secondaries with terminal line composed of blackish lunules between veins. Greatest expanse of forewing 16mm. Genitalia as in fig. 48.

Larval stage: Unknown

Hostplant: One label states "privet" for the first of the bivoltine generations. Nothing is recorded pertaining to the late summer, or second brood.

Specimens examined: MISSOURI: Holotype male, Barnhart, Jefferson County, 25 June 1935 (E.P. Meiners), Bauer-Buckett slide no. 66B2-23 (in collection American Mueum of Natural History). Paratypes: 1 female (designated allotype) same data as holotype; 6 females, same locality and collector as holotype, 25-27 June 1935; 1 female, same locality and collector as holotype, 15 June 1937; 6 males, 1 female, same locality and collector as holotype, 26 August 1933; 6 males, 4 females, same locality and collector as holotype, 26 August 1937; 1 female, St. Louis City, St. Louis County, "L.P. Anas". TENNESSEE: 1 male, 1 female, Memphis, Shelby County, 18 June 1934, (Guedet Collection) 1 male, Loche, 7 June 1934 (Guedet Collection). LOUISIANA: 1 female, Baton Rouge, East Baton Rouge County, 1 June 1895, (J.B. Smith Colection); 1 male, "La.", label with No. 16070, (Collection Dr. H.G. Dyar), Bauer-Buckett slide no. 67C31-25, (in collection of United States National Museum); 2 males, Baton Rouge, East Baton Rouge County, "bd. privet", 19 June 1913 (E.L. Tucker), Chittenden No. 139; 1 female, same locality as preceding, 3 June 1928, L.S.U. Expt. 246.

This species is somewhat variable in both maculation and size. The latter factor is associated with the second of the bivoltine broods, and can possibly be attributed to the developing larvae in relation to diet nutritional values. Average forewing expanse for the spring brood is $\pm$14mm for males and $\pm$16.35mm for females; whereas, in the summer brood the average forewing expanse is $\pm$11.13mm for males, and $\pm$12.8 mm for females. As can be seen by the figures, there is a great amount of variation in size of this species. The broad "golden" transverse lines will serve, in themselves, to assist in recognition of this species.

It is also interesting to note the distribution of *monillata* (see fig. 3) as it seems to occur only along the Mississippi River and it is the eastern most known species in distribution as is thus far known. This distribution may be used as a diagnostic tool, with considerable reliance.

REFERENCES

BARNES, WM., and J. McDUNNOUGH, 1917. Check list of the Lepidoptera of Boreal America. Herald Press, Decatur, Illinois, 392 + viii pp.

BARNES, WM., and J. McDUNNOUGH, 1918. Notes and new species. *Contrib. Nat. Hist. Lep. N. America* 4(2):61-179 + plates 11-25.

COMSTOCK, J. A., 1934. Studies in Pacific Coast Lepidoptera. *Bull. S. Calif. Acad. Sci.* 33:34-48, including 6 plates.

DYAR, H. G., 1903 (1902). A list of North American Lepidoptera and key to the literature of this order of insects. *Bull. U.S. Nat. Mus.* No. 52, xix + 723 pp.

HULST, G. D., 1896. A classification of the Geometrina of North America, with descriptions of new genera and species. *Trans. American Entomol. Soc.* 23:245-386 + plate 10 and 11.

McDUNNOUGH, J. H., 1938. Check list of the Lepidoptera of Canada and the United States of America, part 1. *Mem. S. Calif. Acad. Sci.* 274 pp.

MUNZ, P. A. and D. D. KECK, 1959. A California Flora. Univ. of Calif. Press, Berkeley and Los Angeles, 1681 pp, incl. 134 figures.

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman B. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distributional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W.J. Reinthal and J.T. Mithell. Send data to Dr. W.J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U.S.A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P.O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P.O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W.T.M. Forbes. Entomological Reprint Specialists. P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B.M. Endicott. Distributed in U.S.A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P.O. Box 433, New York, N.Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A.I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

Centurie de Lepidopteres de L'ile De Cuba. P.H. Poey, 1832. C.W. Classey, 353 Hanworth Road, Hampton, Middlesex, U.K. in the U.S.A. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 9 Number 1 March, 1970

IN THIS ISSUE

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 9 *Number 2* *June, 1970*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Established in 1962

Edited by WILLIAM HOVANITZ

Volume 8

1969

Published at
1160 W. Orange Grove., Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 9(2):65-74, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

PRIMARY GEO-ORIENTATION IN SOD WEBWORM MOTHS

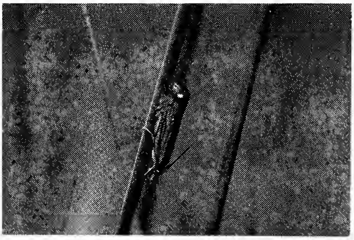
CLIFFORD S. CRAWFORD

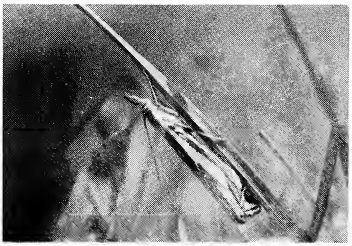
Department of Biology, The University of New Mexico, Albuquerque

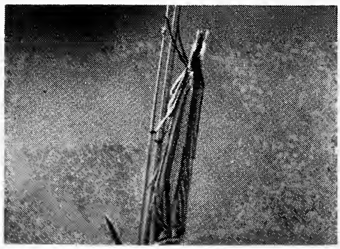
GRAVITY IS A RELATIVELY UNCHANGING STIMULUS to which animals respond with characteristic primary orientations, these being the positions they adopt when inactive and from which they generally become active. One such response is the common transverse orientation in which "the belly is downward" (Fraenkel and Gunn, 1961). Another primary orientation in animals is manifested by the long axis of the body parallelling the pull of gravity.

Relatively few studies have dealt with the second response. In one of these studies Wilson (1964) carefully recorded many observations of geo-orientation by adults of *Choristoneura fumiferana* Clemens, the spruce budworm. He concluded that most of the time the insect rested in a geonegative (facing upward) position within 30° of the vertical. In another investigation on Lepidoptera Keiper (1968) found that in 14 species of *Catocala* moths adult resting positions were consistently either geopositive or geonegative, depending on the species.

Pyralid moths of the subfamily Crambinae typically inhabit areas where representatives (crops as well as grasses) of the Gramineae abound. Crambinae with grass-feeding larvae are called sod webworm moths and are often encountered resting on grass leaves and stems. The moths are slender, with closely folded wings, and in most instances the angle of inclination of the longitudinal axis parallels the longitudinal axis of the leaf or stem on which the insect is resting. Such positioning renders the resting insect fairly inconspicuous to human observers and presumably to predators as well.







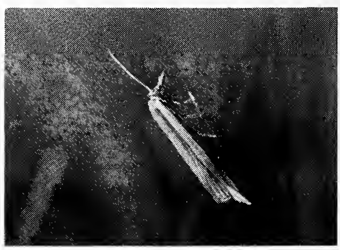


Fig. 1—*Chrysoteuchia topiaria,* male.
Fig. 2—*Chrysoteuchia topiaria,* female.
Fig. 3—*Crambus praefectellus,* male.
Fig. 4—*Crambus sargentellus,* male.
Fig. 5—*Crambus whitmerellus,* female.
Fig. 6—*Crambus harpipterus,* female.

As will be documented in this paper, some of the resting moths tend to orient geopositively, others geonegatively, and still other species form a third group that is more difficult to characterize in terms of primary orientation to gravity. In addition, secondary geo-orientations, assumed when moths are walking, copulating, and ovipositing, can be superimposed on any of the primary orientations. The object of this paper is to describe the basic primary orientations exhibited by resting sod webworm moths and whenever possble to relate these orientations to groups of taxa. Names of species and genera are based on a continuing revision of the Crambinae by Dr. A. B. Klots (North America) and on the work of the late Dr. S. Bleszynski (elsewhere).

CRAMBINAE WITH TYPICAL GEOPOSITIVE ORIENTATION

Chrysoteuchia topiaria Zeller.—I discuss this insect first, because since it was first reported that the moths "face up or down" (Crawford and Harwood, 1964), it has become apparent from many observations that such an oversimplification must be qualified. The following discussion also illustrates some of the complexities of geo-orientation which probably apply to all species of Crambinae.

Most subsequent observations were made near Portland, Oregon, and at the Middle Rio Grande Experiment Station near Belen, New Mexico, where a population existed for several years on experimental plots of western wheatgrass, *Agropyron smithii* (Crawford, 1967). Other populations were noted in the Brazos, Jemez, and Sangre de Cristo Mountains in northern New Mexico.

Male *C. topiaria* display a strong geopositive tendency upon landing (Fig. 1), an observation confirmed by Klots (personal communication). (As with many crambine adults, the usual landing site is a blade or stem of grass.) When the landing orientation is geonegative the body is usually and rapidly turned 180°. I have frequently followed a single male in flight, noted its orientation on landing, then disturbed it and followed it through additional flights and landings. Seldom has such a male faced away from the ground.

Females usually assume a geopositive orientation, too. In contrast with males, however, they often remain facing upward after landing that way (Fig. 2). In this geonegative position

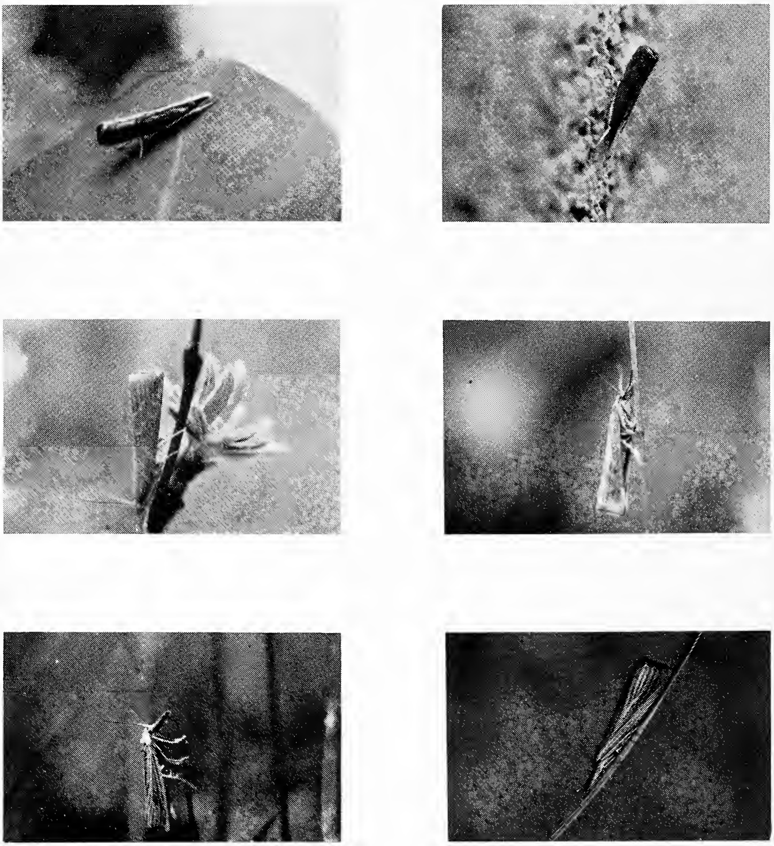


Fig. 7—*Crambus teterrellus*, male.
Fig. 8—*Crambus teterrellus*, male.
Fig. 9—*Tehama bonifatella*, sex unknown.
Fig. 10—*Tehama bonifatella*, sex unknown.
Fig. 11—*Agriphila plumbifimbriella*, female.
Fig. 12—*Agriphila plumbifimbriella*, male.

and especially when they are gravid, females of many Crambinae tend to bend the head forward rather than keeping it aligned with the long axis of the body as is the case in positive geo-orientation. At this time the antennae, which are otherwise generally held close to the back, extend approximately at right angles from the body (see Fig. 5 and Fig. 11 for good examples of this posture).

Negative geo-orientation among female *C. topiaria* seems to be most frequent (in daylight hours at least) during the afternoon when oviposition is maximal (Crawford, 1967). Positive geo-orientation does not, however, preclude oviposition. Moths in this position can and do release eggs which occasionally become trapped in the space between the abdomen and the closely folded wings.

Pediasia spp.—Prescott (1965) observed numerous Crambinae in different parts of Oregon. He reports characteristic geo-positive orientation during the day for *P. trisecta* Walker and *P. dorsipunctella* Kearfott. I observed large numbers of *P. dorsipunctella* on 14 August, 1964, between Mitchell and Prineville, Oregon. Both sexes were present and settled on grass in a stand of large ponderosa pines. All individuals faced down, with wings and abdomen projecting outward from the grass stalk.

Klots (personal communication) states that *P. mutabilis* (Clemens), which is not closely related to the above species in this very diverse genus, "is the most extreme species I know for resting head down." According to Ainslie (1923a), "They alight abruptly, usually on a grass stem, and instantly turn head downward and stand with the head pressed closely to the stem and the body elevated at a considerable angle."

I have observed *P. luteolella* Clemens males oriented geo-positively in the Jemez Mts. One female displayed negative geo-orientation. Prescott (1965) states that the resting posture is "face down."

Others.—According to Hudson (1928) *Crambus tuhualis* Felder from New Zealand holds its wings "upwards at an angle of about 15 degrees from the object on which this insect is standing." Judging from the portrait of this species in Hudson's book I strongly doubt that it really belongs in the newly revised genus *Crambus* (sensu stricto).

CRAMBINAE WITH TYPICAL GEONEGATIVE ORIENTATION

Crambus spp.—Geonegative resting orientation seems characteristic of both sexes in a number of species in this genus.

Crambus tutillus McDunnough was abundant in grass fields near Portland, Oregon, during June in 1963 and 1964. Mr. Hubert Prescott and I spent a profitable afternoon in the field together exchanging notes on the behavior of this species, and he subsequently reported on the resting posture (Prescott, 1965). I noted that while females when viewed from the side closely resembled the lateral aspect of geonegatively oriented *Chrysoteuchia topiaria, C. tutillus* males tended to hold the head in the plane of the body axis and to keep the antennae against the back. This posture appears to hold generally for other male *Crambus*. However, during sexual activity male antennae are often held horizontally and tend to wave, probably in response to pheromones released from females.

Crambus cyrilellus Klots was observed in central New Mexico in July and August. Individuals of both sexes showed a geonegative resting posture.

Crambus praefectellus (Zincken), a widely distributed species in the United States, is fairly common in the Jemez Mts. of New Mexico. Observations of individuals in the field and of laboratory-reared specimens disclosed that geonegative orientation is typical of this group (see Fig. 3) although I have seen some individuals that occasionally oriented themselves otherwise. According to Ainslie (1923b), they seldom "rearrange their position after lighting," and instead of elevating the posterior of the body at a slight angle, maintain the body "closely parallel with the surface on which they rest."

Crambus sargentellus Klots flies in late spring and early summer in the Jemez Mts. Its geonegative resting behavior was seen both in wild individuals (nearly all males) and in females confined to vials during oviposition tests. Figure 4 shows a male at rest.

Crambus whitmerellus Klots was captured infrequently in high meadows in the Jemez and Sangre de Cristo Mountains. Resting behavior in this species (see Fig. 5) is very similar to that of *C. sargentellus*.

Crambus harpipterus Dyar is another Jemez Mts. crambine, both sexes of which invariably face upward when settled. I have had ample opportunity to observe the behavior of these

moths in July and August from 1966 to 1969. Figure 6 shows a female at rest.

Crambus cypridalis Hulst is a late-summer flier in the Pacific Northwest, where Prescott (1965) reported that its resting position was geonegative.

Crambus biothanatalis Hulst, according to Prescott (1965) in Oregon, has a resting posture of "head up." An additional comment on this species is given at the end of this paper.

Argyria spp.—Klots (personal communication) states that those he has seen [*A. nivalis* (Drury), *A. auratella* (Clemens), and *A. critica* (Forbes)] "rest head up." He considers that these are not *Argyria* in the strict sense.

CRAMBINAE WITH TYPICAL MIXED GEO-ORIENTATION

Crambus teterrellus (Zincken).—Not a *Crambus* in the strict sense (Klots, personal communication), this species on first eaxmination exhibits a simple enough pattern of mixed geo-orientation, sometimes resting geopositively, sometimes geonegatively, and sometimes somewhere in between. When subjected to further scrutiny, however, the pattern is found to be qualified by physical, temporal, and perhaps sexual attributes. Ainslie (1930) reported that these moths rest on grass only infrequently during the day. Instead they prefer as resting sites broad-leafed plants (see Fig. 7), walls of buildings, and other objects. During the warmest and brightest time of day they are quiescent. When resting on leaves they assume a variety of positions. On walls, however, they frequently face downward (Fig. 8). In doing so they closely resemble *Pediasia* species. During the early afternoon in late August I once noted that out of the first 100 individuals counted on a single large wall, 98 were oriented in a distinctly geopositive manner. Yet at night, when both sexes are active, females especially and males frequently land upright on grass and other objects.

Tehama bonifatella (Hulst).—In the two regions where I observed this species, I was unable to characterize its geo-orientation as anything but mixed. This consideration is true for the few specimens seen in the Jemez Mts. of New Mexico (see Fig. 9-10) and for the many viewed near Portland, Oregon. During the day I once released about 20 specimens into a room. Most landed on walls, and their long axes presented no consistent geo-orientation pattern. Prescott (1965) considers their resting posture to be "head up or indifferent."

Agriphila spp.—The resting geo-orientation of at least three species in this genus has been recorded. Burton (1968) noted that in England *A. tristella* (Denis and Schiffermüller) "spend the day sitting head downwards on grass-stems." Prescott (1965) remarks that in Oregon the resting posture of *A. vulgivagella* Clemens is "probably head down." My extensive observations of *A. plumbifimbriella* Dyar in New Mexico suggest to me that both the above authors were recording primarily the geo-orientations of males. Certainly males of *A. plumbifimbriella* are much more conspicuous than are females during the daytime. Females stay in grass close to the ground and seldom fly in daylight. When disturbed, they occasionally fly, but also tend to drop to the ground and appear dead. Females seem to rest geo-negatively much of the time, especially when ovipositing during the afternoon (Fig. 11). Males, however, very often face downward during the day (Fig. 12). Yet this diurnal orientation by males is by no means invariable.

Euchromius sp., probably *ocelleus texanus* (Robinson).—Observations in different parts of New Mexico lead me to conclude that this insect rests geo-negatively more often than not. Geo-positive orientation seems to occur about one-fourth of the time.

DISCUSSION AND CONCLUSIONS

Although the observations reported above are limited to relatively few species in the large subfamily Crambinae, certain group-related patterns of geo-orientation are evident. The consistency of the patterns is probably greatest when one considers only resting males, especially in species not exhibiting mixed geo-orientation.

Without exception, at least to my knowledge, observations of resting individuals in the genus *Crambus* (s.s.) have shown their primary geo-orientation typically to be negative. Only eight species of *Crambus* are discussed in this paper; however, I feel that eight is a sufficient number to allow a prediction that negative geo-orientation obtains for the other members of this genus. If the prediction is valid, then we have an instance of a stereotyped behavior pattern that augments a taxonomic grouping based on morphology.

While negative geo-orientation has so far been restricted to species of *Crambus*, and to several species once listed under *Argyria*, the opposite resting posture is also characteristic of at least one newly established genus. Membership in *Pediasia* may

well be associated with positive geo-orientation by resting moths. Geo-orientation in *Chrysoteuchia* other than *C. topiaria* has apparently not been reported. The genus seems well represented in the Palearctic (Bleszynski, 1965). Perhaps this study will stimulate European lepidopterists to make appropriate observations.

Mixed geo-orientations, as I have referred to them, are definitely found in one—and most likely in three species of *Agriphila.* According to Klots (personal communication) the species called *Crambus biothanatalis* by Prescott (1965) is really an *Agriphila.* Prescott's notation of its geonegative orientation (see above) suggests that more and careful recordings of *Agriphila* resting positions be made to determine if mixed geo-orientation is indeed a trait of this genus. My observations on *Crambus teterrellus, Tehama bonifatella,* and *Euchromius ocelleus texanus* suggest to me that mixed geo-orientation will be found in many other crambine species.

ACKNOWLEDGMENTS

I am grateful to Dr. Alexander B. Klots, Research Associate of the American Museum of Natural History, for checking my use of scientific names and for supplying useful information. My colleague, Dr. J. David Ligon, provided constructive criticism of the manuscript. This work was partially supported by a grant from the Research Allocations Committee at the University of New Mexico.

LITERATURE CITED

AINSLIE, G. G. 1923a. Striped sod webworm, *Crambus mutabilis* Clemens. J. Agr. Res. 24:399-414.

AINSLIE, G. G. 1923b. Silver-striped webworm, *Crambus praefectellus* Zincken. J. Agr. Res. 24:415-426.

AINSLIE, G. G. 1930. The bluegrass webworm. USDA Tech. Bull. 173. 26 p.

BLESZYNSKI, S. 1965. Microlepidoptera Palearctica. Vol. I. Crambinae. Georg Fromme and Co., Vienna. 553 p.

BURTON, J. 1968. The Oxford Book of Insects. Oxford Univ. Press, London. 208 p.

CRAWFORD, C. S. 1967. Oviposition rhythm studies in *Crambus topiarius* (Lepidoptera: Pyralidae: Crambinae). Ann. Entomol. Soc. Amer. 60:1014-1018.

CRAWFORD, C. S., and R. F. HARWOOD. 1964. Bionomics and control of insects affecting Washington grass seed fields. Wash. State Univ. Agr. Exp. Sta. Tech. Bull. 44, 25 p.

FRAENKEL, G. S., and D. L. GUNN. 1961. The Orientation of Animals, Kineses, Taxes, and Compass Reactions. Expanded ed. Dover Publications, Inc., New York. 376 p.

HUDSON, G. V. 1928. The Butterflies and Moths of New Zealand. Ferguson and Osborn, Ltd., Wellington. 386 p.

KEIPER, R. R. 1968. Field studies of *Catocala* behavior. J. Res. Lepid. 7:113-121.

PRESCOTT, H. W. 1965. Report on Oregon crambid moth collection by Forest Grove Station. USDA Agr. Res. Serv. Special Report X-227. 7 p.

WILSON, L. F. 1964. Observations on geo-orientation of spruce budworm, *Choristoneura fumiferana,* adults. Ann. Entomol. Soc. Amer. 57:645-648.

Journal of Research on the Lepidoptera 9(2):75-88, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

SEASONAL DISTRIBUTION OF "MACROLEPIDOPTERA" IN SANTA CLARA COUNTY, CALIFORNIA

PAUL A. OPLER and J. S. BUCKETT

University of California
Berkeley, California

University of California
Davis, California

THIS STUDY WAS UNDERTAKEN to delineate the features of flight periodicity of nocturnal "Macrolepidoptera" at New Almaden, Santa Clara County, California, during a single calendar year. This area lies to the east of the Santa Cruz Mountains of coastal Central California. Additionally, a comparison of the macrolepidopterous fauna of New Almaden with that of four other sites in California and Oregon is made.

METHODS

During 1964, moths were collected by Opler on 150 nights at New Almaden, Santa Clara County, California. The number of collecting nights was not disproportionate during any one month. The highest number of nights was for February (16), while the lowest number was for December (7). The number of collecting nights for the other months ranged from 10 to 15. The longest period in which no sampling was conducted was 11 days. The amount of time spent collecting per night was not equal, and the time of night was not always the same. Usually collections were made from dusk to about 11:30 P.M.

Moths were attracted to a 15 Watt unfiltered Ultra-Violet light fixture suspended over a vertical white sheet and collected individually from the sheet. Subsequently, most individuals were determined by Buckett. Finally, the collection was deposited in the entomology collection at San Jose State College.

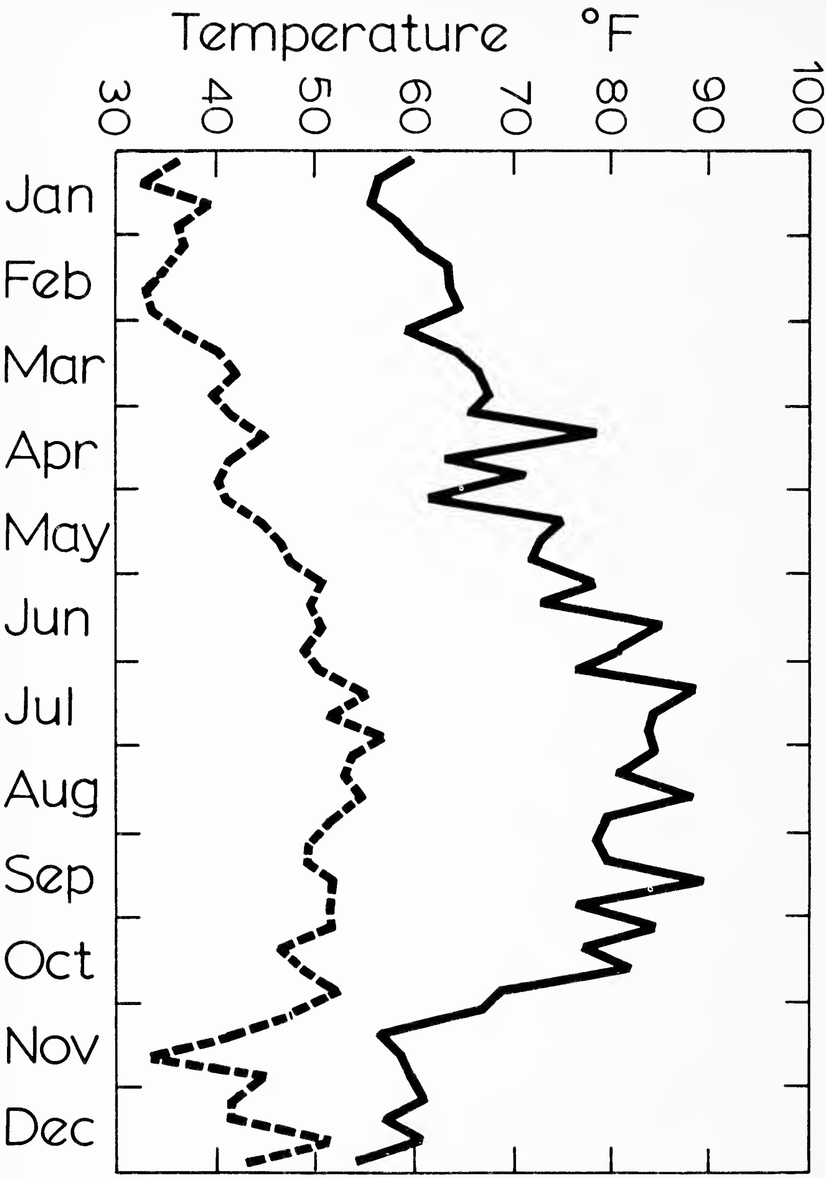


Fig. 1.—Fluctuations of weekly maximum and minimum temperatures for 1964 at Los Gatos, Santa Clara County, California.

STUDY SITE

The study site was the Opler residence at 20861 Almaden Road, New Almaden, Santa Clara County, California. This site was adjacent to a grove of mature coast live oaks (*Quercus agrifolia* Neé) at the base of an east-facing slope. To the west was an undisturbed area of oak woodland and coastal chaparral (this area has been subjected to overgrazing since the study was completed). Immediately to the east was a small orchard composed of a wide variety of fruit trees (unsprayed for 20+ years), while further to the east was a permanent creek and a west-facing slope of grassland.

The geology of this area was described in detail by Atkinson (1942). All surface formations of the area belong to the Franciscan Formation which is of Jurassic Age. The east-facing slope is of a sandstone base, while the west-facing slope is the edge of an extensive serpentine outcrop.

Conspicuous perennial floral elements show that the area is ecotonal between the Californian and Oregonian Biotic Provinces, although the Californian elements are strongest. The Santa Cruz Mountains lie immediately to the west, and are one of the southernmost expressions of the Oregonian Province. Below are listed the commonest perennial species in the immediate vicinity of the site: (1) East-facing slope—*Acer macrophyllum* Pursh., *Aesculus californica* (Spach), *Artemisia californica* Less., *Baccharis pilularis* D. C., *Lotus scoparius* (Nutt.), *Mimulus aurantiacus* Cart., *Heteromeles arbutifolia* M. Roem., *Quercus agrifolia* Neé, *Q. douglasii* H. & A., *Q. kelloggii* Newb., *Q. lobata* Neé, *Rhamnus californica* Esch., *Rhus diversiloba* T. & G., *Ribes californicum* H. & A., *Rubus vitifolius* Cham. & Schlecht, *Salvia laris* Suksd., *Umbellularia californica* (H. & A.), *Vaccinium laris* Suksd., *Umbrellularia californica* (H. & A.), *Vaccinium ovatum* Pursh.; (2) Stream—*Alnus rhombifolia* Nutt., *Artemisia douglasiana* Bess., *Baccharis glutinosa* Pers., *Platanus racemosa* Nutt., *Salix lasiolepis* Benth.; (2) West-facing slope—*Arctostaphylos* sp.

CLIMATE

The climate is of a mediterranean type with a cool wet season and a warm dry season. During the summer months high fog occurs on many nights, while the warmest nights occur in late summer and fall after the end of the fog season. Temperature data recorded at Los Gatos during 1964 are presented on Figure 1. Los Gatos, nine airline miles from New Almaden, is only 65 feet lower in elevation and occupies a nearly identical situation at the eastern base of the Santa Cruz Mountains.

MOTHS

During the year, individuals of 205 species of moths of the families Sphingidae, Saturniidae, Nolidae, Arctiidae, Noctuidae, Geometridae, Notodontidae, Lasiocampidae, Liparidae, and Dioptidae were collected.

The seasonal occurrence of 92 species collected on five or more occasions is shown graphically by Figures 2, 3 and 4. Univoltine species are shown first in order of their seasonal appearance. The species are followed by bivoltine, trivoltine and finally, homodynamic species. Since only the first initial of the generic names is given, the appropriate species numbers from McDunnough (1938) are appended. The remainder of the species, together with earliest and latest dates of capture, are as follows:

SPHINGIDAE —

Sphinx perelegans Hy. Edw. (V-24)
Pholus achemon Dru. (V-15, IX-7)
Arctonotus lucidus Bdv. (I-16)
Celerio lineata Fabr. (IV-7, IX-26)

SATURNIIDAE —

Hyalophora euryalus Bdv. (IV-11, V-9)
Antheraea polyphemus Cram. (IV-21, VI-12)

NOLIDAE —

Celama minna Butl. (I-22, III-7)
Sarbena minuscula Zell. (I-31, III-19)

ARCTIIDAE —

Halisidota maculata angulifera Wlk. (V-13)
Estigmene acrea Dru. (IV-20, VIII-7)
Maenas vestalis Pack. (II-16, IV-20)

NOCTUIDAE —

Acronicta lepusculina felina Grt. (VII-5)
A. marmorata Sm. (VII-17, X-4)
A. impleta illita Sm. (VI-26, VII-12)
A. perdita Grt. (IV-24)
Euxoa olivia Morr. (XI-29)
E. niveilinea Grt. (X-11)
E. feniseca Harv. (X-11)
E. sponsa monteclara Sm. (VII-5, VII-12)
E. difformis Sm. (X-23)
E. henrietta Sm. (IX-27)
E. obeliscoides Gn. (IX-3)
E. excellens Grt. (X-4, XI-7)

Pseudorthosia variabilis pallidior Ckll. (IX-28, X-10)
Feltia annexa Treit (X-19)
Metalepsis cornuta Grt. (II-16)
Graphiphora c-nigrum L. (V-13)
Abagrotis trigona Sm. (VII-26, IX-10)
A. baueri McD. (X-23)
A. reedi Buckett (VII-5)
Ufeus satyricus Grt. (XII-7)
Admetovis similaris Barnes (VI-1)
Lacinipolia vicina sareta Sm. (IX-27, X-4)
Tricholita fistula Harv. (IX-28, XI-30)
Protorthodes alfkeni Grt. (IX-26, X-27)
Xylomyges cognata minorata B. & McD. (I-16, XI-30)
Stretchia inferior Sm. (I-16)
S. pacifica McD. (II-5)
Acerra normalis Grt. (III-3, IV-10)
Orthosia pulchella Harv. (III-3, XI-14)
O. ferrigera puncticostata Dyar (IV-20)
O. macona Sm. (I-17, II-19)
Perigonica angulata Sm. (IV-14, V-12)
Leucania farcta Grt. (V-10, XI-3)
Rancora serraticornis Lint. (I-10, II-5)
Cucullia dentilinea Sm. (IV-20)
Pseudobryomina fallax Hamp. (I-14, XI-22)
Behrensia conchiformis Grt. (I-16)
Apamea cuculliformis Grt. (VI-14)
A. arctica Frr. (VI-14)
A. castanea Grt. (VI-1)
Aseptis perfumosa Hamp. (VI-24, VII-11)
A. fumeola Hamp. (VII-5, VII-12)
Oligia marina Grt. (VI-14)
Procis divesta Grt. (VII-12, VIII-9)
Cerma oaklandiae B. & McD. (VIII-5, IX-20)
Agriopodes viridata Harv. (VII-11, X-10)
Amphipyra pyramidoides Gn. (VIII-7, X-19)
A. glabella brunneolatra Strand (VII-27, VIII-5)
Neperigea niveirena Harv. (VI-1)
N. albimacula B & McD. (VII-21, VIII-8)
Platyperigea extimia Wlk. (IX-18, X-4)
Proxenus mindara B. & McD. (VII-5, VIII-7)
Prodenia praefica Grt. (VI-26)
Helicoverpa phloxiphaga G. & R. (IV-20)
H. zea Boddie (IX-12, X-25)

Autographa biloba Steph. (I-16, XI-25)
Catocala aholibah Stkr. (VII-5)
C. irene Behr (VIII-26)
C. faustina Stkr. (X-4)
Caenurgina erechtea Cram. (VI-1)
C. togataria Wlk. (IX-12, XI-29)
Zale termina Grt. (V-8)
Cissusa indiscreta Hy. Edw. (III-3, III-11)
Synedoida ochracea Behr (VI-26)
S. divergens Behr (VI-16, VII-27)
Scoliopteryx libatrix L. (VI-14)
Camptylochila lubricalis occidentalis Smith (VII-25, VIII-7)
Tetanolita palligera Sm. (VI-3, VI-12)

NOTODONTIDAE —
Lophopteryx americana Harv. (IV-14)
Cerura cinerea cinereoides Dyar (IV-14, VIII-6)
C. scolopendrina Bdv. (III-14, VII-27)

GEOMETRIDAE —
Alsophila pometaria Harr. (I-16)
Nemoria delicataria Dyar (VIII-21, XI-22)
Metasiopsis granitaria Pack. (VI-23)
Scopula cacuminaria Morr. (VII-17)
S. quinquelinearia Pack. (VI-14, VI-22)
Coryphista meadi Pack. (IX-7)
Eupithecia graefi Hlst. (VI-5)
Ceratodalia gueneata Pack. (VI-24)
Stamnodes affiliata Pears. (VII-11)
Hydriomena albifasciata puncticaudata B & McD. (II-2)
H. edenata Swett (III-2)
Percnoptilota obstipata Fabr. (XI-25)
Venusia pearsalli Dyar (V-10)
Drepanulatrix carnearia Hlst. (IX-20, IX-27)
Semiothisa respersata Hlst. (VIII-9, IX-26)
S. muscariata Gn. (VII-12)
S. excurvata Pack. (V-12, X-4)
Hesperumia sulphuraria Pack. (VII-12, VII-29)
Pteroptaea sp. (VII-11, VII-12)
Aethaloida packardaria Hlst. (VII-11, X-4)
Palaeacrita longiciliata Hlst. (I-14, XII-8)
Gabriola dyari Tayl. (X-4)
Thallophaga taylorata Hlst. (VI-22, VIII-5)
Phengommataea edwardsata Hlst. (X-11)
Synaxis hirsutaria B. & McD. (XI-11, XI-27)

Prochoerodes truxaliata Gn. (X-4, X-11)
P. forficaria Gn. (XII-4)

As can be seen by an examination of Figures 2, 3 and 4 there is a continual appearance and disappearance of species throughout the year. McFarland (1963) stated that at Corvallis, Oregon, there were seven periods during the year, each of which was characterized by a certain group of moths. Although the impressions I gained during 1964 generally agree with these divisions, the data presented do not support this theory. Perhaps a more detailed analysis using more extensive data will bear out McFarland's thesis.

As noted in an analysis of butterflies of Contra Costa County (Opler and Langston, 1968) univoltine species tend to be monophagous, while homodynamic species tend to be largely polyphagous. That this is true can be seen by an examination of Figures 2 to 4. On Figure 4 the eight species of widest seasonal occurrence are all known to be polyphagous. Additionally, all except *Pero mizon* are of considerable economic importance.

FAUNAL COMPARISON

The nocturnal "macrolepidopterous" faunae of three other locations in California and one in Oregon have been intensively studied through at least one complete season. These are as follows: (1) Santa Monica Mountains, near Beverly Hills, Los Angeles County, California, 10 years (McFarland, 1965); (2) Walnut Creek, Contra Costa County, California, six years, unpublished study by J. A. Powell; (3) Knox Mountain, 20 airline miles southwest of Alturas, Modoc County, California, four years, unpublished study by R. L. Dalleske; (4) Corvallis, Benton County, Oregon, three years (McFarland, 1963). A chart presenting the composition of the macromoth fauna of each locality by superfamily is shown as Figure 5. A triangular matrix of number of species shared in common between each site and the percent commonality with the total species of the paired localities is presented as Figure 6. Separate matrices for the Noctuoidea and Geometroidea are also presented (Figures 7 and 8).

Dice (1943) divided North America into 29 Biotic Provinces. Each of these provinces covers a considerable and continuous

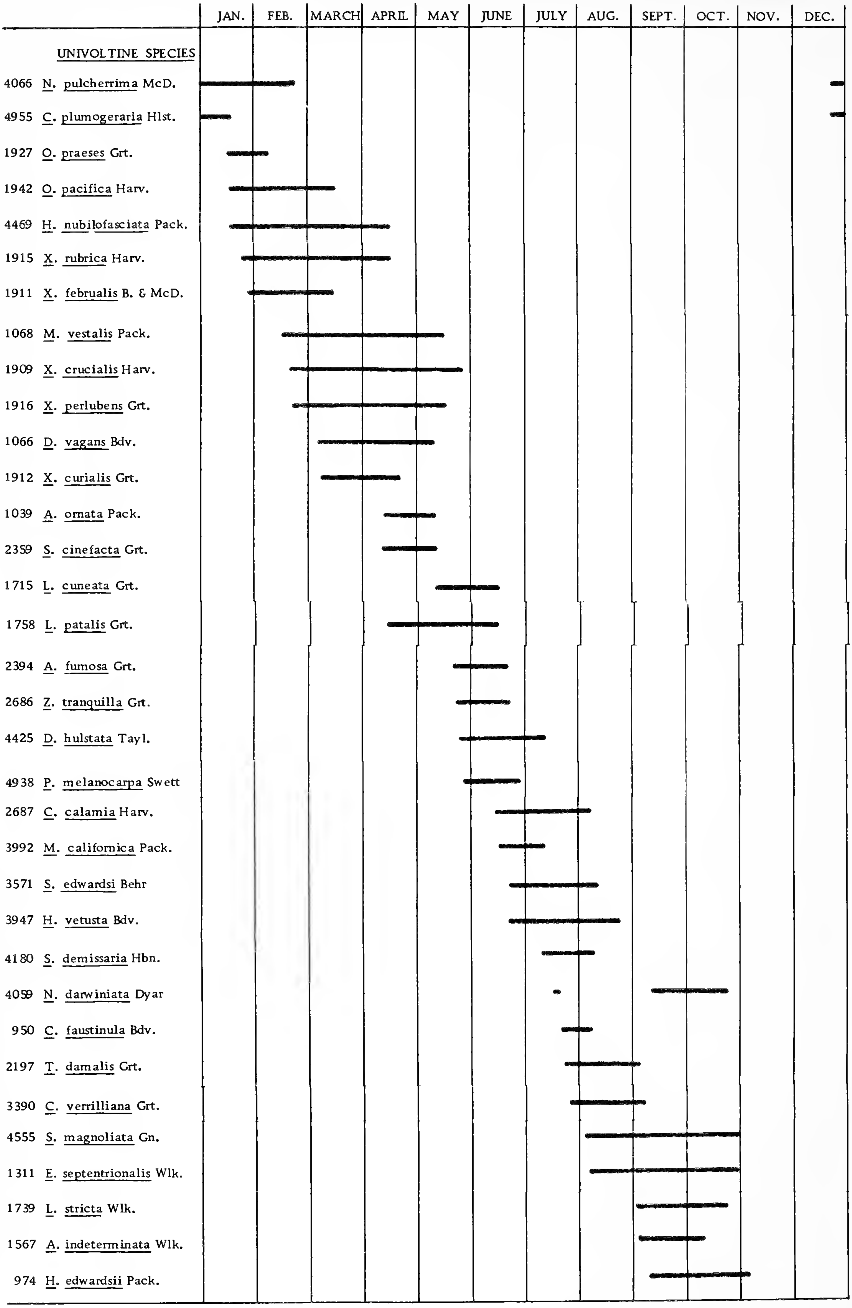
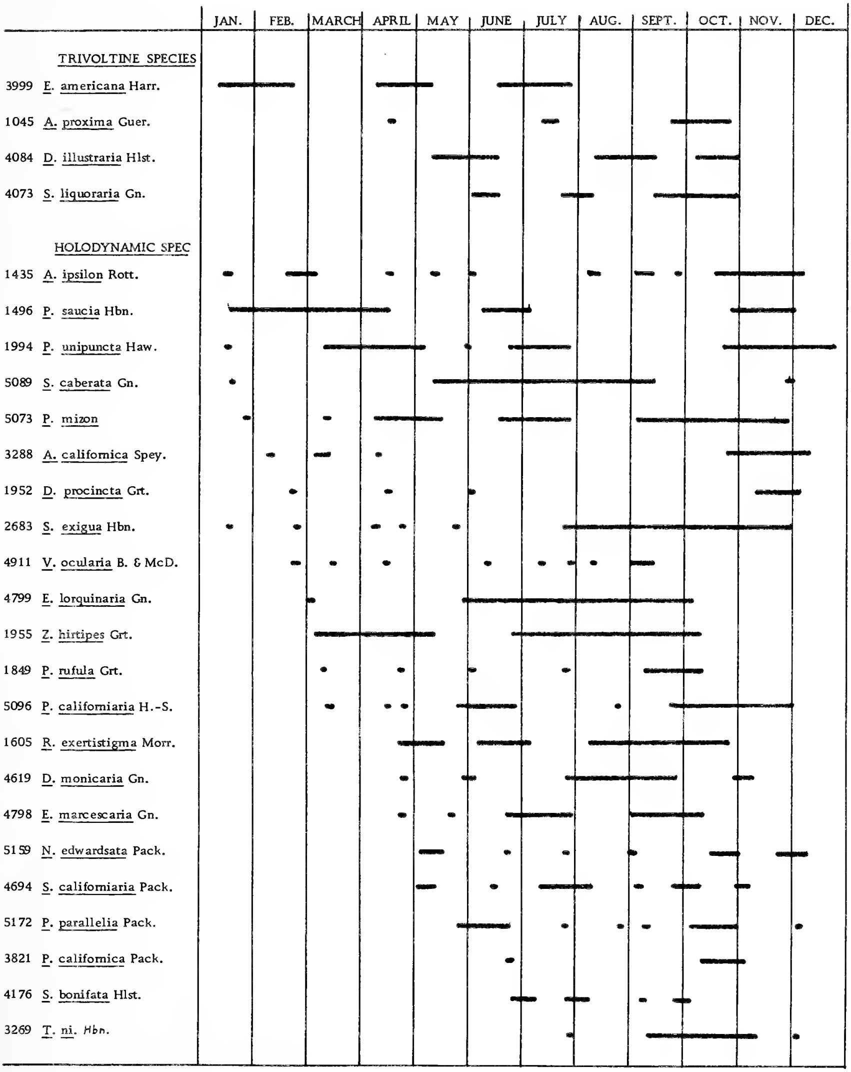
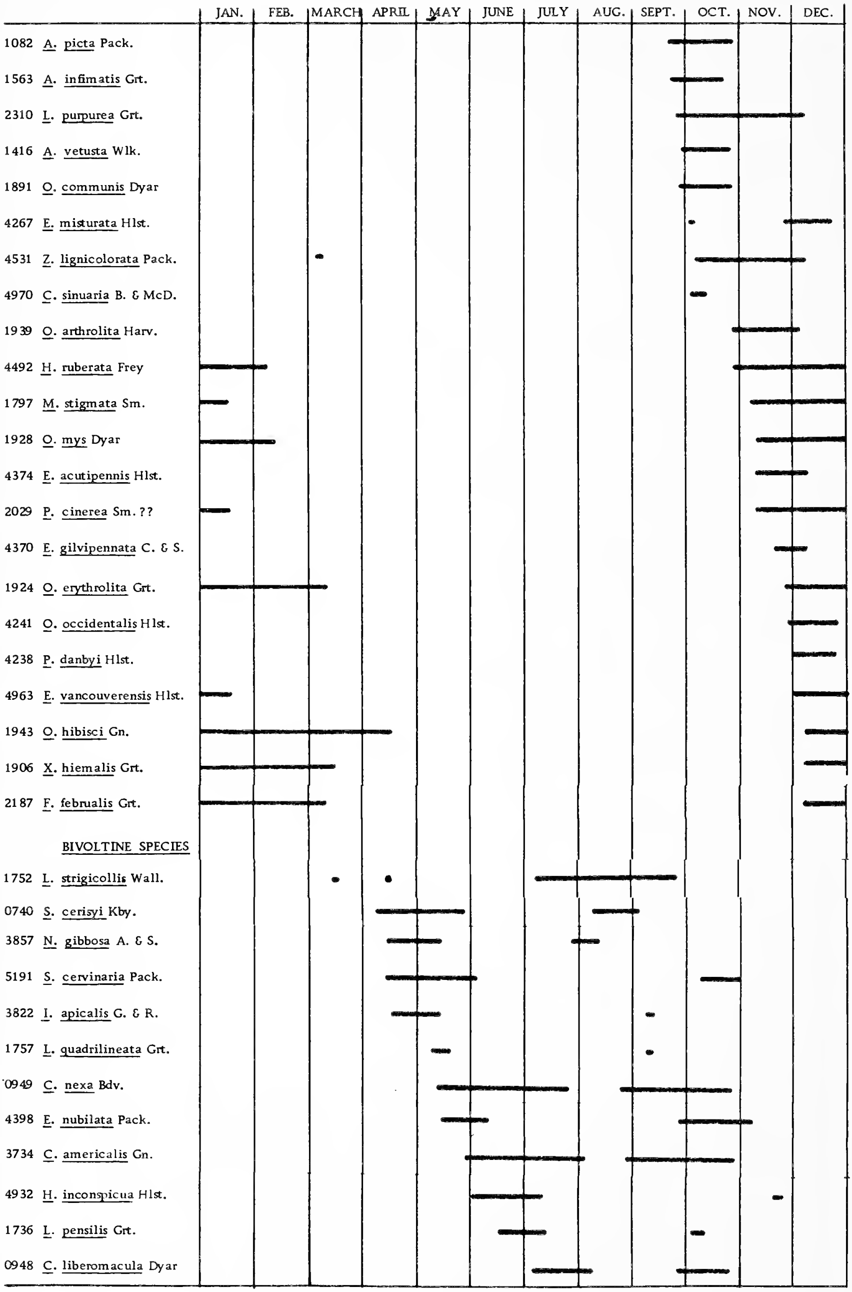


Fig. 2 to 4.—Seasonal occurrence of species collected on five or more nights at New Almaden in 1964. *Cochisea sinuaria* occurred on only three nights but was so common that it was included.


JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
TRIVOLTINE SPECIES
3999 E. americana Harr.
1045 A. proxima Guer.
4084 D. illustraria Hlst.
4073 S. liquoraria Gn.
HOLODYNAMIC SPEC
1435 A. ipsilon Rott.
1496 P. saucia Hbn.
1994 P. unipuncta Haw.
5089 S. caberata Gn.
5073 P. mizon
3288 A. californica Spey.
1952 D. procincta Grt.
2683 S. exigua Hbn.
4911 V. ocularia B. & McD.
4799 E. lorquinaria Gn.
1955 Z. hirtipes Grt.
1849 P. rufula Grt.
5096 P. californiaria H.-S.
1605 R. exertistigma Morr.
4619 D. monicaria Gn.
4798 E. marcescaria Gn.
5159 N. edwardsata Pack.
4694 S. californiaria Pack.
5172 P. parallelia Pack.
3821 P. californica Pack.
4176 S. bonifata Hlst.
3269 T. ni. Hbn.


JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1082 A. picta Pack.
1563 A. infimatis Grt.
2310 L. purpurea Grt.
1416 A. vetusta Wlk.
1891 O. communis Dyar
4267 E. misturata Hlst.
4531 Z. lignicolorata Pack.
4970 C. sinuaria B. & McD.
1939 O. arthrolita Harv.
4492 H. ruberata Frey
1797 M. stigmata Sm.
1928 O. mys Dyar
4374 E. acutipennis Hlst.
2029 P. cinerea Sm. ??
4370 E. gilvipennata C. & S.
1924 O. erythrolita Grt.
4241 O. occidentalis Hlst.
4238 P. danbyi Hlst.
4963 E. vancouverensis Hlst.
1943 O. hibisci Gn.
1906 X. hiemalis Grt.
2187 F. februalis Grt.
BIVOLTINE SPECIES
1752 L. strigicollis Wall.
0740 S. cerisyi Kby.
3857 N. gibbosa A. & S.
5191 S. cervinaria Pack.
3822 I. apicalis G. & R.
1757 L. quadrilineata Grt.
0949 C. nexa Bdv.
4398 E. nubilata Pack.
3734 C. americalis Gn.
4932 H. inconspicua Hlst.
1736 L. pensilis Grt.
0948 C. liberomacula Dyar

	New Almaden (1 year)	Walnut Creek (5 year)	Santa Monicas (10 year)	Modoc County (4 year)	Corvallis, Oregon (3 year)
SPHINGOIDEA	5	5	5	6	5
SATURNIOIDEA	2	0	2	1	2
NOCTUOIDEA	134	155	168	209	198
BOMBYCOIDEA	2	4	2	5	5
DREPANOIDEA	0	0	0	0	8
GEOMETROIDEA	62	68	92	58	129
TOTAL SPECIES	205	232	269	279	345

Fig. 5.—Composition of "Macroheterocera" faunae at five localities in California and Oregon.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	——				
Walnut Creek	36 39%	——			
Santa Monicas	35 29%	34 27%	——		
Modoc County	10 9%	10 9%	12 9%	——	
Corvallis, Oregon	28 17%	28 17%	27 14%	18 11%	——

Fig. 6.—Table showing number of species in common and percentage similarity between macromoth faunae.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	95 49%	———			
Santa Monicas	87 40%	96 42%	———		
Modoc County	52 27%	44 14%	45 14%	———	
Corvallis, Oregon	74 29%	72 26%	67 23%	58 17%	———

Fig. 7.—Similarity table for Noctuoidea.

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	36 39%	———			
Santa Monicas	35 29%	34 27%	———		
Modoc County	10 9%	10 9%	12 9%	———	
Corvallis, Oregon	28 17%	28 17%	27 14%	18 11%	———

Fig. 8.—Similarity table for Geometroidea.

geographic area and is characterized by a number of ecological associations that differ from the associations of adjacent provinces. Three of the above studies, New Almaden, Santa Monica Mountains, and Walnut Creek, are located within the Californian Biotic Province. The Modoc County locality is located within the Artemisian Biotic Province; while the Corvallis, Oregon, study site is located within the Oregonian Biotic Province. By referring to Figure 6, one can see that the three Californian localities are highly correlated with each other. No pairing between any two of these localities produces a correlation lower than 35 percent. The next highest correlations are between Corvallis, Oregon, and the three Californian localities. While Corvallis has greater faunal affinities to the north and east (McFarland, 1963), a number of plants are congeneric with California plants and support nearly similar moth faunae, e.g., *Acer, Quercus, Ribes, Rhamnus, Salix, Sambucus,* etc. The Modoc County locality shows least correlation with all other sites. This is due to the strong Artemisian and montane Californian influences in its make-up.

A similar ranking of relationships but of varying magnitudes is shown by the separate matrices for Noctuoidea and Geometroidea (Figs. 7 and 8). It should be noted that correlations for noctuoids are higher than those for geometroids in all cases. This can be explained by the facts that noctuoids are more robust insects with presumably greater dispersal capabilities, and that the family contains relatively more polyphagous, polyvoltine species.

SUMMARY

During 1964, 205 species of moths of the superfamilies Sphingoidea, Saturnioidea, Noctuoidea, Bombycoidea, and Geometroidea were taken at New Almaden, Santa Clara County, California.

The seasonal occurrence of these moths is presented graphically and briefly discussed.

A comprison of the New Almaden moth fauna with those of four additional localities in California and Oregon is presented.

ACKNOWLEDGEMENTS

We thank Robert L. Dalleske, University of California, Berkeley; Noel McFarland, Adelaide, Australia; and Jerry A. Powell, University of California, Berkeley, for permission to use data

from their studies. J. G. Edwards and J. W. Tilden, San Jose State College, San Jose, California, provided encouragement at the inception of this study. Robert L. Dalleske and Jerry A. Powell made a number of helpful suggestions and reviewed the manuscript of this paper. Mrs. Paul (Sandra) Opler and the Division of Entomology, University of California, Berkeley, provided welcome secretarial assistance.

LITERATURE CITED

ATKINSON, J. E. 1942. Geology of the Guadalupe Quicksilver mine and vicinity. Unpublished Master's thesis in Geology. University of California, Berkeley, 50 pp.

DICE, L. R. 1943. The Biotic Provinces of North America. University of Michigan Press, Ann Arbor, 78 pp.

McDUNNOUGH, J. H. 1938. Check list of the Lepidoptera of Canada and the United States of America. Part. 1. Macrolepidoptera. *Mem. So. Calif. Acad. Sci.* 1:1-272.

McFARLAND, N. 1963. The Macroheterocera (Lepidoptera) or a mixed forest in western Oregon. Unpublished Master's thesis. Oregon State University, Corvallis.

————. 1965. The moths (Macroheterocera) of a chaparral plant association in the Santa Monica Mountains of Southern California. *Jour. Res. Lepid.* 4(1):43-74.

OPLER, P. A. and LANGSTON, R. L. 1968. A distributional analysis of the butterflies of Contra Costa County, California. *Jour. Lepid. Soc.* 21(2):89-107.

Journal of Research on the Lepidoptera 9(2):89-96, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

BOTANICAL NAMES IN ENTOMOLOGICAL PAPERS AND HABITAT STUDIES

NOEL McFARLAND

2 Gulfview Rd.

Blackwood, South Australia 5051

There is a distinct need, in all fields of zoological writing, for more *consistency* and *accuracy* in the recording of botanical names. When phytophagous species are involved, or the paper deals with distribution or habitat description, etc., it is inexcusable for the writer to be any less accurate with the plant names than he is with the names of insects (or other animals) mentioned in the same paper. Three major points should always be kept in mind:

(1) Give the COMPLETE SCIENTIFIC NAME, whenever accurate determination is possible (genus, species, and variety if any). *At least* include the generic name.

(2) If the scientific name has been fully determined, include also the COMPLETE CITATION OF AUTHOR(S). Note the differences between zoological and botanical rules of nomenclature with regard to complete author citations (Lanjouw et al., 1966). As in zoological writing, where the same scientific name is repeated more than once in a paper, the author citation need only be given once (preferably at the first place in the text where the name is used.)

(3) The plant FAMILY should always be given once, as a matter of course, for every plant generic name mentioned in a paper, *at least in the case of foodplant records.* The importance of this point to those who are interested in distribution, or rearing and life history investigation, cannot be over-emphasized. (For a world dictionary of the families of described genera of flowering plants and ferns see Willis, 1966.)

A certain percentage of lepidopterists are, of course, quite familiar with the families of (at least some) plants in their own local districts or countries. But the major need for including families arises when one considers readers in other countries; they will often overlook (or fail to realize) very interesting comparisons of foodplant preferences (between certain insects in their own country and others covered in a foreign paper), if the family name is not included. When one does not have access to the Willis dictionary—and many do not—it can sometimes be very difficult to discover the family of an unfamiliar foreign plant genus, and particularly in the case of tropical plants. It is but little extra work for the author to include plant family names *at the time of the writing;* in the process of determination he will come across the families anyway, or will learn them from plant taxonomists.

This thought is directed to any lepidopterist in North America whose interests extend beyond mere political borders: If you were interested in lycaenids, and saw reference to a foodplant of certain Australian *Ogyris* spp. (large, metallic-blue hairstreaks) given simply as the plant generic name "*Amyema*," this might not convey much, nor would it greatly increase your worldwide understanding of lycaenid foodplant preferences. . . . *However,* had the writer bothered to include, in parentheses after *Amyema,* the family name (LORANTHACEAE — a mistletoe), considerable interest, and increased potential understanding, would have been instantly incorporated into the paper with but slight additional effort on his part. Similarly, how many Australian readers of an American paper, upon seeing the plant generic name "*Phoradendron*" mentioned as the foodplant of a large, metallic-blue hairstreak widespread in the United States (*Atlides halesus* Cramer), would recognize this generic name instantly as applicable to a plant *also* in the LORANTHACEAE? Such omissions, to the *potential* value of papers containing foodplant records, are seen everywhere in the literature (including, I readily confess, earlier papers by the present writer).

Knowledge of a possible foodplant family is exceedingly useful to those wishing to rear larvae (from eggs obtained in captivity) of a moth or butterfly whose foodplant is entirely unknown, as is so frequently the case in Australia, New Guinea, Central or South America, and Africa, for example.

If one knows the family to which belongs a foodplant of the *nearest relative* of the insect one is trying to rear (even if the only plant recorded is of but a distant relative), one's chances for locating an *acceptable* foodplant are considerably increased. (This often means the difference between failure and success in obtaining larvae for preservation and study.) Knowing the foodplant genus, of a near relative of the insect,

is *not* necessarily always as helpful as knowing the family to which its foodplant belongs; experience will demonstrate this point time and again. Far more alternatives come up for consideration when one knows the foodplant family. (McFarland, 1961, 1964).

To carry this one step higher, it is sometimes equally helpful to know the order to which a possible foodplant might belong. For a worldwide summary of plant orders, and most of the families contained in each, see Benson (1957), pp. 110-114, 328, 500, 536; also, see Melchior (1964), and Thorne (1968). Thorne's synopsis includes superorders (-iflorae), orders (-ales), suborders (-ineae), families (-aceae), and subfamilies (-oideae), and is worthy of close study by anyone interested in lepidopterous early stages or distribution, etc.

While still on the topic of plant families, the need for *standardization* of all family name endings (column B, below), now being recognized by more and more botanists (for example Eichler, 1965; Thorne, 1968), should be mentioned. This is certainly in keeping with any desire for clarity and consistency. All animal family names now in use consistently end with "-idae." Why not 100% consistency with plants? The following 8 family names (column A) are the only remnants of this long-standing inconsistency:

(A) Sanctioned by long usage, but ending irregular:		(B) Alternative family name using standard ending:
Compositae	(or)	ASTERACEAE
Cruciferae	(or)	BRASSICACEAE
Gramineae	(or)	POACEAE
Guttiferae	(or)	CLUSIACEAE
Labiatae	(or)	LAMIACEAE
Leguminosae	(or)	FABACEAE
Palmae	(or)	ARECACEAE
Umbelliferae	(or)	APIACEAE

Whether or not the name with the standard ending (derived from the name of a genus in the family) is applied remains a matter of individual choice; *either* ending is correct (according to the Code) in the above cases. The tendency, however, should be toward uniformity or standardization, especially in view of the fact that the remaining (approx.) 98% of described plant families are known by regularly formed names with the standard ending, while the above 8 families form a 2% exception to the rule as long as the names in the first column remain in use.

If the Leguminosae are treated as *one* family, use FABA-

CEAE; if split up into 4 families (or subfamilies, according to the writer's interpretation), examples or representative genera would be as follows: MIMOSACEAE or Mimosoideae (*Acacia, Albizia, Calliandra, Mimosa, Prosopis,* etc.); CAESALPINIACEAE or Caesalpinioideae (*Caesalpinia, Cassia, Cercidium, Cercis, Gleditsia, Gymnocladus, Tamarindus,* etc.); KRAMERIACEAE or Kramerioideae (only one American genus, *Krameria*); FABACEAE or Faboideae (includes by far the majority of genera, among which are *Astragalus, Crotalaria, Daviesia, Dillwynia, Faba, Genista, Lathyrus, Lotus, Lupinus, Medicago, Melilotus, Pultenaea, Robinia, Trifolium, Vicia, Wisteria,* etc.).

The following family name is almost invariably misspelled: "Capparidaceae"; this name is based on the genus *Capparis* L., and should be CAPPARACEAE (Eichler, 1965; Melchior, 1964; Lajouw et al., 1966, p. 212). Naiadaceae should be replaced by NAJADACEAE, Oenotheraceae by ONAGRACEAE, etc.

Agreement on the use of the terms "foodplant" and "host plant" is needed. In most earlier writings the former was apparently quite adequate, in connection with plants upon which larvae were known to feed; it is a simple and perfectly clear, useful word. (See Wheeler, 1939). Torre-Bueno (1937, pp. 105 and 129), separates these two terms in a way worthy of serious consideration in the interest of consistency. They should continue to be defined as he suggested:

(1) "*HOST PLANT*—the plant on which an insect species has its preferred haunt or abiding place; in predacious Heteroptera, fixed by the preferred prey which lives on it."

(2) "*FOODPLANT*—the plant on which an insect habitually *feeds;* not to be confused with host plant, on which the insect lives, since certain predacious forms haunt particular plants, which are the foodplants of their prey." (In view of its extensive use in entomological writing, "foodplant" is perhaps best written as one word, not separated or hyphenated; it then reads more smoothly, is written more easily, and stands out more clearly in the text.)

When the term host plant is employed in discussions connected with parasites, their hosts, and the plants eaten by the larval hosts, confusing or awkward wording can easily arise ("host plant of the host" or "the host host plant," etc.!); this is hard to avoid unless the term *foodplant* is used to refer to the plant eaten by the host.

In view of its extensive use in entomological writing, foodplant

is perhaps best written as *one* word, unbroken; it then stands out more clearly in the text and reads more smoothly.

In connection with foodplant names on the labels of reared insect specimens, an unfortunate practice is widespread and should be stopped: This is the habit many collectors have of writing only the utterly useless word "bred" or "reared" (or some equivalent) on the label, occupying valuable space where, alternatively, the name of the plant genus (at least!) could appear, if not in fact the full name. Even if the collector kept a notebook in which foodplants were supposedly recorded, it often develops that the book cannot be found when it is needed, or its references are unclear in their application, or it was lost when he died (*or etc.*)—so his collection goes to the local museum carrying with it proof that he could rear Lepidoptera with success, but never is a plant name to be found on one of his labels! In such a collection it is not at all uncommon to come across reared species for which the foodplant is unpublished, and (once the collector has died) unknown, and *so it remains;* the potential value of his collection is thus reduced.

Plant identifications should never be glibly passed along from one worker to the next if the slightest doubt exists. Careful re-checking sometimes upsets deeply entrenched myths about supposed foodplants or preferences. Foodplant names intended for publication should always be re-checked (or verified) by a plant taxonomist. Where any uncertainty still remains, the writer should not be afraid to make use of the question-mark. Always double-check author citations in the most recent scholarly reference available for the locality. (For example, in the case of Black's South Australian flora, see Eichler, 1965.)

When foodplant records are new or were previously doubtful, or are from remote habitats, or when the determination is uncertain, it is highly advisable to collect good specimens, pressing, drying, and mounting them carefully, and including the exact locality, elevation, exposure, soil type, date, and collector's name on all labels. Such specimens should then be code-numbered and deposited in a herbarium, and reference to this fact should be made clear in related entomological papers. By "good" plant specimens I mean specimens as nearly complete as possible, which include buds, flowers, young and mature fruits, the *range* of leaf sizes and shapes, and typical stems. Obviously this is not always possible, but should be kept clearly in mind when collecting botanical material for identification. In the case of smaller plants, collect the entire plant in order to show the type of root system, and possible differences in basal leaves, etc. In the case of larger plants, a few comments about the

general growth-habit (shape, type of branching, average and maximum heights, etc.) are often valuable to include in the note-book entry or on the field label; also include notes on the trunk and bark (or *any* other distinctive features not shown by the collected material) of trees, shrubs, or vines. Such information will greatly facilitate identification when it is attempted later, and is very often required for a reliable determinaton at the specific or varietal level.

When reading long habitat plant-lists, check-lists of insects, or lists of foodplants, etc., it is generally more useful to find these in *alphabetical* order (at least from the genus down), for ease of comparison with other published information of a similar nature. (See McFarland, 1963, 1965b, 1967; McFarland and Colburn, 1968.) This is almost always a desirable refinement in format, with one major exception: When one wishes, for a definite reason, to show or imply phylogenetic relationships or evolutionary trends, and that is *the primary aim of the paper.* (For example, Ehrlich and Raven, 1964.)

With the snowballing world population explosion, leading to greatly increased pressure (direct and indirect), on all "wild" lands, the sooner biologists study the remaining unspoiled habitats with their present plant-animal associations, and *publish* this information, the better. As communications and world travel become ever more rapid, we are entering a period where insect families and genera, in relation to their habitats and foodplants, can be quickly, accurately, and *meaningfully compared* by workers the world over. Consistently accurate botanical determinations, coupled with unfailing mention of the plant families involved, would help to speed up this synthesis. Of course, attention to numerous other details, not discussed in this paper, would also help among these lines. Again, *consistency and uniformity of terminology and presentation* (format) would be key points.

REFERENCES

ATLAS OF AUSTRALIAN RESOURCES (1955)—(a) "Vegetation Regions" (large map); (b) Commentary prepared for this map by R. J. Williams (23 pp.). Dept. of National Development: Canberra.

BEARD, J. S. (ed.), (1964). Descriptive Catalogue of West Australian Plants. *Pub. of the Soc. for Growing Australian Plants.* 122 pp.

BENSON, L., (1957). Plant Classification. D. C. Heath & Co., Boston. 688 pp.

BLACK, J. M., (1943-1957). Flora of South Australia (2nd ed.), Parts I-IV, Govt. Printer, Adelaide. 1008 pp.

BREEDLOVE, D. E. and P. R. EHRLICH (1968). Plant-Herbivore Coevolution: Lupines and Lycaenids. *Science* 162:671-672.

BURBRIDGE, N. T., (1963). Dictionary of Australian Plant Genera (Gymnosperms and Angiosperms). Angus & Robertson: Sydney. 345 pp.

CANNON, W. A., (1914). Specialization in vegetation and environment in California. *Plant World* 17:223-237.

________ (1921). Plant Habits and Habitats in the Arid Portions of South Australia. *Carnegie Inst. of Wash.* pub. No. 308. 139 pp., 32 plates.

COOPER, W. S., (1922). The broad-sclerophyll vegetation of California. *Carnegie Inst. Publ.* No. 319.

DEBENHAM, C. N., (1963). The Language of Botany. *Pub. of the Soc. for Growing Australian Plants.* 64 pp.

DETHIER, V. G., (1954). Evolution of feeding preferences in phytophagous insects. *Evolution* 8:33-54.

________ (1959). Foodplant distribution and density and larval dispersal as factors affecting insect populations. *Canad. Ent.* 91:581-596.

DOWNEY, J.C., (1962). Host-plant relations as data for butterfly classification. *Syst. Zool.* 11:150-159.

DOWNEY, J. C. & W. C. FULLER, (1961). Variation in *Plebejus icarioides* (Lycaenidae). I. Foodplant specificity. *J. Lepid. Soc.* 15:34-42.

EHRLICH, P. R., (1968). The Population Bomb. Ballantine Books, New York. 223 pp.

EHRLICH, P. R. & P. H. RAVEN, (1964). Butterflies and plants: A study in coevolution. *Evolution* 18:586-608.

EICHLER, H., (1965). Supplement to J. M. Black's Flora of South Australia. Govt. Printer, Adelaide. 385 pp.

EYRE, S. R., (1963). Vegetation and Soils, A World Picture. Edward Arnold, London. 324 pp.

FORBES, W. T. M., (1958). Caterpillars as botanists. *Proc. 10th Int. Congr. Ent.* 1:313-317.

GOOD, R., (1966). The Geography of the Flowering Plants, 3rd. ed. Longmans, Green & Co., London. 518 pp.

JACKSON, B. D. (1953). A Glossary of Botanic Terms with Their Derivation and Accent, 4th ed. Duckworth, London. 481 pp.

JANZEN, D. H., (1966). Coevolution of Mutualism Between Ants and Acacias in Central America. Evolution 20(3):249-275.

________ (1968). Host Plants as Islands in Evolutionary and Contemporary Time. *Amer. Naturalist* 102(928):592-595.

LANJOUW, J. et al., (ed.), (1966) International Code of Botanical Nomenclature. *Regn. Veget.* 46:1-402.

MacKAY, M. R., (1964). The relationship of form and function of minute characters of lepidopterous larvae, and its importance in life-history studies. Canad. Ent. 96(7):991-1004.

________ (1966). An editorial. *Canad. Ent.* 98(8):785-788.

McFARLAND, N., (1961). Notes on the early stages of *Daritis* (*howardi?*) (PERICOPIDAE) from Cabezon Peak, New Mexico. *J. Lepid. Soc.* 15(3):172-174.

________ (1963). The Macroheterocera (Lepidoptera) of a mixed forest in Western Oregon. Thesis submitted to Oregon State Univ., Entomology Dept., Corvallis, Oregon. 152 pp.

________ (1964). Notes on collecting, rearing, and preserving larvae of Macrolepidoptera. *J. Lepid. Soc.* 18(4):201-210.

________ (1965a). Additional notes on rearing and preserving larvae of Macrolepidoptera. *J. Lepid. Soc.* 19(4):233-236.

———— (1965b). The Moths (Macroheterocera) of a Chaparral Plant Association in the Santa Monica Mountains of Southern California. *J. Res. Lepid.* 4(1):43-73.

———— (1967). Spring Moths (Macroheterocera) of a Natural Area in Northeastern Kansas. *J. Res. Lepid.* 6(1):1-18.

———— and P. W. COLBURN, (1968). Notes on the original vegetation of a single locality in the eastern Santa Monica Mountains, California. *Lasca Leaves* 18(1):1-18. (Quarterly pub. of the Calif. Arboretum Foundation.)

MAYR, E., E. G. LINSLEY, and R. L. USINGER, (1953). Methods and Principles of Systematic Zoology. McGraw-Hill, New York. 336 pp.

MELCHIOR, H. (ed.), (1964). A Engler's Syllabus der Pflanzenfamilien, 12th ed., Vol. 2. Berlin. 666 pp.

MUNZ, P. A. and D. D. KECK, (1959). A California Flora. *Univ. of Calif. Press,* Berkeley. 1681 pp.

REMINGTON, C. L., (1952). The biology of nearctic Lepidoptera. I. Foodplants and life histories of Colorada Papilionoidea. *Psyche* 59: 61-70.

SCHIMPER, A. F. W., (1903). Plant geography upon a physiological basis. English transl. by A. W. Fisher. 839 pp.

SHIRÔZU, T., (1962), Evolution of the food-habits of larvae of the thecline butterflies. *Trans. Lepid. Soc. Japan* 12:144-162.

STEARN, W. T., (1966). Botanical Latin. Nelson, London, 566 pp.

THORNE, R. F., (1968). Synopsis of a putatively phylogenetic classification of the flowering plants. *Aliso* 6(4):57-66.

THORSTEINSON, A. J., (1960). Host selection in phytophagous insects. *Ann. Rev. Ent.* 5:193-218.

TORRE-BUENO, J. R. de la, (1937). A Glossary of Entomology. Pub. by Brooklyn Ent. Soc., New York. 336 pp., 9 plates.

TULLOCH, G. S. (ed.), (1960). Torre-Bueno's Glossary of Entomology— Supplement A. Pub. by Brooklyn Ent. Soc., New York, 36 pp.

WHEELER, W. M., (1939). Essays in Philosophical Biology, pp. 117-142. Harvard Univ. Press, Cambridge. 261 pp.

WILLIS, J. C., (1966). A Dictionary of the Flowering Plants and Ferns, 7th ed., revised by H. K. Airy Shaw. Cambridge Univ. Press, London. 1267 pp.

Journal of Research on the Lepidoptera 9(2):97-99, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

CONCERNING *COLIAS EURYTHEME ALBERTA* BOWMAN (PIERIDAE)

JOHN H. MASTERS[1]
Lemon Street North, North Hudson, Wisconsin 54016

Colias eurytheme alberta was described by Bowman (1942) but has received little attention other than by Bowman himself (1944, 1951), and dos Passos (1964) places *alberta* as a subspecies of *Colias alexandra* Edwards. A close examination of a Bowman paratype in the U.S. National Museum and of Bowman's original description confirms that *alberta* is not related to *Colias eurytheme* but to that part of the *Colias alexandra* population best known as *Colias christina Edwards.* I believe that Bowman actually redescribed *Colias alexandra christina* and his name should be sunk as an absolute synonym.

Bowman's description of alberta and his placing of it under *eurytheme* Boisduval appears to be based on two mistaken assumptions that he held: (1) Those *alexandra/christina* blend zone speciments from southern Alberta, which I refer to as *astraea* Edwards, were apparently considered by Bowman to be typical of *Colias christina,* and (2) he apparently considered phenotypical *Colias christina* populations from northern Alberta to be *eurytheme.* Then in 1941, as Bowman relates in his description, there was a large migration of *Colias eurytheme* from the south into Alberta, which gave Bowman an opportunity to compare his Alberta *eurytheme* (actually *christina*) from the Peace River country with typical *eurytheme.* He found them very distinct, as indeed they are, and redescribed *christina* as a subspecies of *Colias eurytheme.* A confirmation of Bowman's errors, in this regard, are to be found in his list of Alberta Lepidoptera (Bowman, 1951) in which he records *christina* as occurring only in the southern and western parts of the province where the

[1]Research Associate, Carnegie Museum, Pittsburgh, Pennsylvania.

astraea forms occur and not at all in the northern parts of the province, where it actually occurs; while recording *eurytheme alberta* only from extreme northern Alberta localities where typical *christina* is known to occur.

A second consideration has been to determine whether *alberta* could be construed to represent a valid subspecies in the *C. alexandra* complex or whether it is an absolute synonym for *christina,* as I have concluded that it is.

The orange phenotype of *Colias alexandra, christina,* occurs from the Great Slave Lake region of the District of Mackenzie, south to Lake Athabasca and the Peace River region of Alberta, eastward through northern Saskatchewan to the vicinity of The Pas, Manitoba, then southward, along the Manitoba Escarpment, to Riding Mountain and the vicinity of Brandon, and then appears again as an isolated population (*krauthi* Klots) in the Black Hills of South Dakota. From southern Alberta and British Columbia through Idaho and Montana to northern Wyoming, there is a broad band of gradual intergradation (forms *astraea* and *emilia* Edwards) of the orange phenotype to the yellow one. The yellow phenotype, nominate *alexandra,* occurs in the Rocky Mountains of southern Wyoming, Colorado, Utah, Arizona and New Mexico and in the Pine Ridge region of northwest Nebraska. Hovanitz (1950) also allied the west coast populations of *Colias occidentalis* Scudder, *C. harfordii* H. Edwards and *C. barbara* H. Edwards with *C. alexandra*, a conclusion that I am inclined to agree with.

I have only examined one paratype of *alberta* (a male in the U.S. National Museum, Wembley, Alberta, 25 June 1925), however, in an examination of specimens from the entire range of *christina* I have found no distinguishing characteristics that could lead to a subspecific designations. Males from Alberta, Saskatchewan and Manitoba are identical and cannot be separated, while South Dakota males (*krauthi*) can be distinguished only by a more greenish appearance ventrally. The females are quite variable in the black borders of the dorsal fore-wings and in the background color with orange, yellow and white forms occurring. However, all forms occur in all localities and if any differences occur, they are of a statistical nature involving the percentages of given forms or combination in a given locality. Actually the type localities of *christina* (the portage of the Slave River between Lake Athabasca, Alberta and Great Slave Lake, District of Mackenzie) and *alberta* (Wembley, Alberta) are quite close together and even if a clinal subspecies in *christina* could be sup-

ported, *alberta* could not apply as it comes from the same end of the cline as *christina*. Manitoba collectors normally call their specimens of *christina* by the subspecific name *mayi* Chermock & Chermock, however *mayi* is actually the Riding Mountain subspecies of *Colias gigantea* Strecker and not *christina* at all (Masters, paper in preparation).

Colias eurytheme alberta ab. *pallidissima* Bowman was described at the same time as *alberta*. This is nothing but the white female, and can be considered a synonym to *pallida* Cockerell, however both are infraspecific names with no standing under The Code (International Code of Zoological Nomenclature). If it is necessary to designate the dimorphic white females, in an infraspecific sense, I feel that it is preferable to use the name "alba" as a *nomen collectivum* for the white females of all dimorphic *Colias* species.

F. Martin Brown of Colorado Springs is currently studying the types of butterflies described by W. H. Edwards and since five of the seven names available in a subspecific sense in the *Colias alexandra/christina* complex were proposed by Edwards, I will not attempt to revise the species until his study is complete.

ACKNOWLEDGMENTS

I wish to thank Dr. William Field of the U.S. National Museum, Washington and Harry Clench of Carnegie Museum, Pittsburgh for allowing me access to types and other specimens in the collections of their respective institutions. Without this assistance, this study would have been impossible.

LITERATURE CITED

BOWMAN, K., 1942. A note on *Colias eurytheme* Bdv., with description of a new race (Lepidoptera, Pieridae). *Canadian Ent.*, 74: 25.

1944. Additions and corrections to the check list of the macrolepidoptera of Alberta. *Canadian Ent.* 76: 191-192.

1951. An annotated list of the Lepidoptera of Alberta. *Canadian Jour. Zoology (Ottawa)* 29: 121-165.

DOS PASSOS, C. F., 1964. A synonymic list of the Nearctic Rhopalocera. *Memoir No. 1, The Lepid. Soc.*, 145 pp.

HOVANITZ, W., 1950. The biology of *Colias* butterflies. I. The distribution of the North American species. *Wasmann Jour. Biol.*, 8: 49- 75.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

HABITAT — *COLIAS VAUTIERI*

This species inhabits nearly the whole of Chile from the deserts of the north to Punta Arenas in the south and from sea level to at least 14,000 feet in elevation. It occupies Argentina from approximately Zapala (north of San Carlos de Bariloche) to the Straits of Magellan. The upper photo shows a meadow in the Andes (Las Garzas, Rio Maulé, Province Talca, Chile) where the species was extremely abundant December 23, 1970; food plant "clovers". Elevation 6-8000 feet. The lower photo shows green meadows along the Rio Limay, Province Rio Negro, about 3,000 feet elevation, Argentina, the most northeasterly known for the species (Plottier, Dec. 8, 1970).

W. Hovanitz

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

COMMENTS ON THE NEARCTIC MEMBERS OF THE GENUS PRECIS HUEBNER

J. W. TILDEN
125 Cedar Lane,
San Jose, Calif. 95127
125 Cedar Lane, San Jose, Calif. 95127

THE GENUS *Precis* Huebner 1819 includes an assemblage of species of nearly world-wide distribution. The new world species have customarily been placed in the genus *Junonia* Huebner 1819. A genitalic examination of three old world species and of the nearctic species as represented by specimens from the United States, Mexico, and South America, indicates that both the old world and the new world species are extremely similar genitalically even in species that differ remarkably in appearance, and in my opinion should be united under one genus. The gentalia of *Precis orithya* (Linnaeus) (Indonesian specimens) and those of *Junonia coenia* Huebner from the United States, are so similar as to leave no doubt of their congeneric relationship. In fact, certain workers, the present author among them, have in the past held that *coenia* might be regarded as a subspecies of *orithya.*

Since custom has fixed the usage of *Precis* for the old world species, and *Junonia* for those of the new world, and since both of these genera were first proposed on succeeding pages of the same work (Huebner, Verz. bek. Schmett. 1819, (3)33, *Precis* and (3)34, *Junonia*), we may look at some of the past history of these two genera to see if any previous worker has expressed an opinion as to which genus should have preference in the event that these two genera should be united.

Selection of the type species for each of these genera was made by Scudder. From among the eight nominal species listed by Huebner under *Junonia,* Scudder in 1872 selected *Papilio*

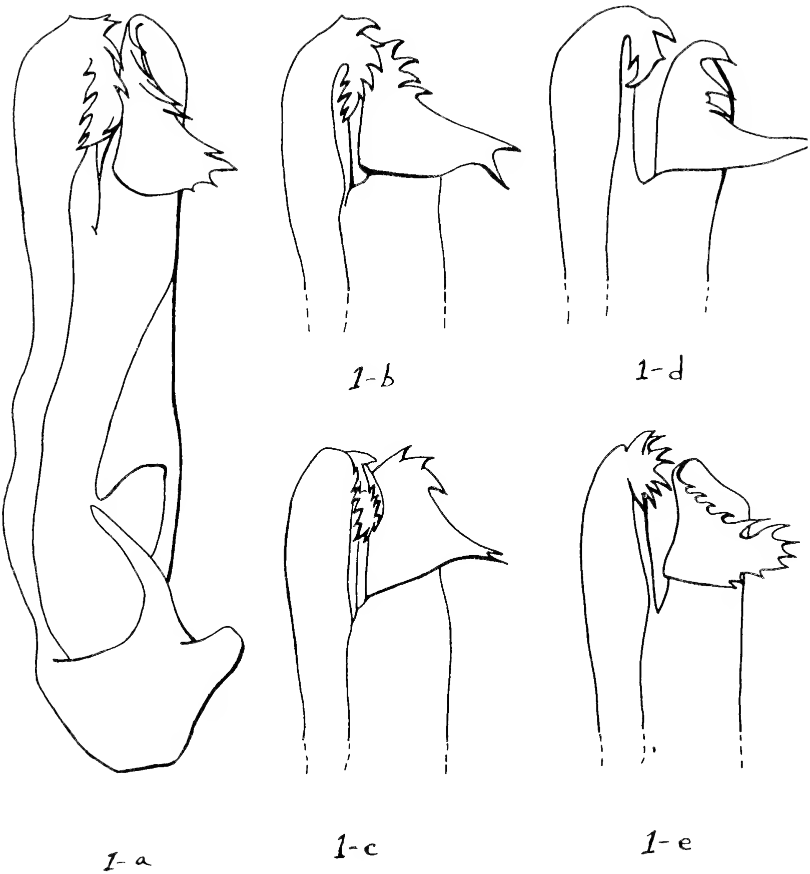


Fig. 1-a.—*Precis coenia* (Huebner), ♂, internal aspect of valve.
Fig. 1-b.—*Precis evarete* (Cramer), ♂, tip of valve.
Fig. 1-c.—*Precis nigrosuffusa* (Barnes & McDunnough), ♂, tip of valve.
Fig. 1-d.—*Precis evarete zonalis* (Felder & Felder), ♂, tip of valve, atypical (?).
Fig. 1-e.—*Precis orithya* (Linnaeus), ♂, tip of valve.

lavinia Cramer 1775 as the type. *Papilio lavinia* Cramer 1775 is considered a junior homonym of *Papilio lavinia* Fabricius 1775. *Papilio lavinia* Fabricius is a moth. Zimsen (1964) considers it a member of the present genus *Urania*. *Papilio lavinia* Cramer is thus unavailable for use as a name in the genus *Precis* (*Junonia* auct.). The oldest available name for *Papilio lavinia* Cramer appears, on subjective taxonomic grounds, to be *Papilio evarete* Cramer 1780.

In 1875 Scudder selected *Papilio octavia* Cramer 1777, an old world species and one of the two species included by Huebner, as the type of *Precis* Huebner. *Precis* has page precedence over *Junonia*. Page precedence, once an established usage, is not now considered binding in decisions of this kind.

In searching the literature for some statement that may be construed as a decision by the first reviser, one is led to that of Hemming, 1935 (Gen. Hol. Butt. I, pp. 73-74), who says "The name *Junonia* Hb., though nomenclatorially valid, is not required, as *lavinia* Cram. is congeneric with *octavia* Cram., the type of *Precis* Hb., which has page priority."

The reference to page priority by Hemming does not, in my opinion, invalidate his action in uniting *Precis* and *Junonia*. It is my belief that the entire assemblage of species now placed under the two genera *Precis* and *Junonia* should be placed under *Precis* Huebner 1819, with *Junonia* Huebner 1819 as a junior synonym.

In America north of Mexico, there are four rather different looking insects representing the genus *Precis* (*Junonia* auct.) The taxonomic treatment of these has not been a matter of general agreement. One species is widely distributed over temperate and tropical North America. The others are largely confined to the southern tier of states, and south into Mexico and South America. Some of these entities are sympatric in certain places, though not necessarily inhabiting identical habitats. Klots (1951, p. 109) notes that in Florida two "so-called subspecies" occur in the same area. While such a situation cannot be stated categorically to be impossible, it does alter the usual concept of subspecies as races that replace one another geographically.

At least six names have been used at one time or another for our nearctic members of *Precis*. These are *coenia* Huebner 1822, *lavinia* Cramer 1775, *evarete* Cramer 1780, *zonalis* Felder & Felder 1867, *genoveva* Stoll 1782 and *nigrosuffusa* Barnes &

McDunnough 1916. In some instances, decisions as to which names are valid for our insects are at least partially subjective. In the case of the older names, where only figures and brief citations exist, the possibility of error is great. Moreover, members of the genus *Precis* are notable for individual variation. The opinions of the present author are given below, but are subject to change in the event of further information.

Precis coenia Huebner, (TL Cuba), the only species of wide distribution in America north of Mexico, is usually distinctive in appearance. The forewing subapical band is white or nearly so, prominent both above and below, and tends to surround the forewing eye spot. The upper (costal) eye spot of the hind wing is at least as large, and nearly always larger than, the forewing eye spot, and is oval in shape. The spines at the tip (cucullus, cuiller) of the valve (harpe) of the male are complex and numerous (Fig. 1-a), and strikingly similar to the same structures in the old world *Precis orithya* Linnaeus. At one time (Garth & Tilden, 1963, p. 33) I believed that the name *evarete* Cramer should be used for what is usually called *coenia* Huebner, and that it should be considered a subspecies of *Precis orithya* Linnaeus. I have had occasion to change both of these ideas, and now consider *coenia* a separate species.

The life history of *coenia* is well known. I have reared it from *Plantago, Mimulus* and *Antirrhinum.* Other food plants of record are *Gerardia, Linaria, Ludvigia, Sedum,* and *Phyla* (= *Lippia*). I am now convinced that some if not all of the references to *Phyla* as a food plant of *coenia* apply to the following species, *Precis evarete* Cramer, which at times has been considered synonymous with *coenia,* or united with it as a subspecies.

Along the southern border of the United States, an insect occurs in which the subapical band of the forewing is buffy, tan or orange. The costal eye spot of the hind wing is smaller than the forewing eye spot, and is round. The forewing apex is a bit more rounded than the forewing of *coenia.* This difference is noted in the figures in Ehrlich and Ehrlich, 1961, but is somewhat over emphasized. This insect has most often been treated as *lavinia* Cramer 1775, a name which, as a junior homonym of *Papilio lavinia* Fabricius 1775, is not available for use in the genus *Precis.* The oldest name that, on subjective taxonomic grounds, may be applied to this insect appears to be *evarete* Cramer 1780.

Cramer's figures of *Papilio lavinia* show a green gloss on the upper side, especially on the hind wings. Specimens with this appearance seem common south of the Meixcan border. The specimens I have seen from the United States do not show green coloration to this degree. The figures of *Papilio evarete* Cramer show a lighter forewing subapical band than is usual in material from the United States. The teeth of the valve tip are shown in Fig. 1-b. This figure is from a specimen taken in Oaxaca, Mexico, but specimens from Texas are nearly identical. Note the reduction of teeth on the projecting process, and the bifurcate condition of the tip of this process.

Precis zonalis F. & F., as represented by specimens from Florida, appears to be conspecific with *evarete,* both on phenetic and genitalic characters. However, some Florida examples lack the bifurcation of the process at the tip of the valve. (Fig. 1-d). *Precis zonalis* F. & F. is currently considered a subspecies of *Precis evarete* Cramer. This usage seems to be justified. It is possible that the specimens of *evarete* from Texas also belong to the subspecies *zonalis,* as some workers have stated.

The food plant of *Precis evarete* is probably Phyla (= *Lippia*).

In 1916 Barnes & McDunnough described *nigrosuffusa* as a subspecies of *Junonia coenia* Huebner, type locality Palmerlee, Arizona. Palmerlee is an old station in the Huachuca Mts., Cochise County. Since that time, it has been found that *nigrosuffusa* occurs in many places in southern Arizona, and extends east to the coastal plain and Offshore Islands of Texas.

Precis nigrosuffusa does not replace *Precis coenia* geographically. Both occur sympatrically over much of the range of *nigrosuffusa.* The two do not seem to mingle in nature, and each has rather different behavior. One food plant is known for *nigrosuffusa,* and I know of no record of this plant being fed upon by *coenia.* Their populations do not seem to peak at the same time. One may take fresh *coenia* and worn *nigrosuffusa* on the same day, and vice versa. There are also minor genitalic differences. It would appear that *nigrosuffusa* is in fact a distinct species.

In both Arizona and Texas, males of *nigrosuffusa* tend to be solitary and very conspicuous. They often perch on open places such as dirt roads or openings in the vegetation. If disturbed they fly away, often high in the air, but eventually return to

near the original site. In spite of the conspicuous behavior, *nigrosuffusa* seems to exist at much lower populational levels than *coenia* in the same places. After hours of observation, I have never seen either species show any interest in the other.

In addition to the very dark coloration, the costal eye spot of the hind wing of *nigrosuffusa* is small and round, and the forewing cell below is usually solid orange-brown. In *coenia* this cell shows the usual orange cell bars separated by ground color. The valve tip of a male *nigrosuffusa* is shown in Fig. 1-c. Note the short pointed process and the reduced number of teeth.

Precis nigrosuffusa has been reared by Roy O. Kendall of San Antonio, and by Everard Kinch of Fort Worth, Texas. The food plant is *Stemodia tomentosa* (Mill.) Greenm. & Thomps. To my knowledge, *nigrosuffusa* has not been reared in Arizona. However, *Stemodia durantifolia* (L.) Schwartz. is known to occur there and should be examined as a possible food plant.

On the basis of these several apparently consistent differences, I feel that *Precis nigrosuffusa* (B. & McD.) should be raised to specific rank. Certain other workers with whom I have discussed this matter are in agreement, but the responsibility for this action is mine.

The name *genoveva* Stoll 1782 has been used at times for one or another of our nearctic populations of *Precis*. Most of the specimens that I have examined under this name are *nigrosuffusa* from Texas. However, specimens of *Precis evarete* Cramer (*lavinia* Cramer auct.) have also been determined as *genoveva*. Ehrlich & Ehrlich (1961) use *lavinia* Cramer for what is here considered to be *coenia* Huebner, and use *genoveva* Stoll for what is here treated as *evarete* Cramer (= *lavinia* auct.). Dos Passos (1864) places *genoveva* as a junior synonym of *evarete* Cramer, a disposition of the name which seems to me to be correct.

In the course of this study the following species of *Precis* were examined:

Precis orithya (L.)
Precis atlites (Joh.)
Precis hierta (Fabr.)
Precis coenia (Hbn.)
Precis evarete (Cramer)
Precis nigrosuffusa (B. & McD.)

Key to the nearctic species of Precis:

1. Costal eye spot of hind wing as large and nearly always larger than, the forewing eye spot; widespread .... *coenia*
   Costal eye spot of hind wing the same size or usually smaller than, the forewing eye spot; southern 2

2. Forewing subapical band orange-brown to yellowish; ground color not dark and suffused .... *evarete*
   Ground color very dark and suffused; cell UNF usually nearly solid orange-brown .... *nigrosuffusa*

The following changes in the dos Passos List are suggested: (forms and aberrations are not listed here)

Genus *Precis* Huebner "1818" (1819)

Type: *Papilio octavia* Cramer 1777

Synonym: *Junonia* Huebner "1818" (1819)

Type: *Papilio lavinia* Cramer 1775

531. *coenia* (Huebner) "1806" (1822)

531.1 *nigrosuffusa* (Barnes & McDunnough) 1916

532. *evarete* (Cramer) "1782" (1780)

a. *e. evarete* (Cramer) "1782" (1780)
lavinia (Cramer nec. Fabricius 1775) "1779" (1775)
genoveva (Stoll) 1782

b. *e. zonalis* (Felder & Felder) "1864-67" (1867)

I wish to thank Dr. Paul Arnaud and the California Academy of Sciences for use of material, Mr. Cyril F. dos Passos and Mr. Paddy McHenry for references, and Mr. Roy O. Kendall and Mr. Everard Kinch for field information and specimens.

SUMMARY

The genus *Precis* Huebner 1819 and the genus *Junonia* are united, with *Precis* having precedence, as suggested by Hemming (1934). The status of the nearctic populations is discussed. *Nigrosuffusa* Barnes & McDunnough 1916, described as a subspecies of *coenia* Huebner 1822, is raised to specific status. A key to nearctic species is given and changes in the 1964 dos Passos Synonymic List of Nearctic Rhopalocera are proposed.

LITERATURE CITED

BARNES, W. & J. McDUNNOUGH. 1916. *Can. Ent.* 48(7):21-26.

CRAMER, PIETER. 1775. *Uitl. Kapellen,* tom. I:28, pl. XIX, ff. C, D (*orithya*) and p. 32, pl. XXI, ff. C, D (*lavinia*).

________. 1777. Op. cit., tom. II:60, pl. CXXXV, ff. B, C (*octavia*).

________. 1780. Op. cit., tom. III:18, pl. CCIII (*evarete*).

DOS PASSOS, CYRIL F. 1964. *Syn. List nearc. Rho*p., pp. 77-78.

EHRLICH, PAUL R., & ANNE EHRLICH. 1961. How to know the Butterflies, pp. 154-155.

FABRICIUS, JOHANN C. 1775. Syst. Ent. III:22, No. 64.

FELDER, C., & R. FELDER. 1867. Reise Novara, Lep. III, p. 399, No. 593.

GARTH, JOHN S., & J. W. TILDEN. 1963. Yosemite Butterflies, p. 33.

HEMMING, FRANCIS. 1934. Gen. Names Hol. Butt. I, pp. 73-74.

________. 1967. Gen. Names Butt., pp. 238 & 375.

HUEBNER, JACOB. 1819. *Verz. bekannt. Schmett.,* (3)33 (*Precis*), & (3)34 (*Junonia*).

________. 1822. *Samm. exot. Schmett.,* band 2 tf. 245(32), ff. 1, 2, 3, 4 (*coenia*).

KLOTS, ALEXANDER. 1951. Field Guide Butt., p. 109.

LINNAEUS, CAROLUS. 1758. *Syst. Nat.* (ed. 10) 1:475, No. 94.

SCUDDER, SAMUEL. 1872. 4th Ann Rept. *Peabody Acad. Sci.,* 1871:43.

________. 1875. *Proc. amer. Acad. Arts. Sci.* 10:256.

STOLL, CASPER. 1782. *Uitl. Kapellen,* tom. IV, pl. CCXC, ff. E, F.

ZIMSEN, ELLA. 1964. Type Material of I. C. Fabricius, 511, no. 7.

Journal of Research on the Lepidoptera 9(2):109-123, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

NOTES ON THE BIOLOGY OF *POANES VIATOR* (HESPERIIDAE) WITH THE DESCRIPTION OF A NEW SUBSPECIES

ARTHUR M. SHAPIRO[1]

Department of Entomology and Limnology, Cornell University, Ithaca, New York 14850

POANES VIATOR (EDWARDS), THE BROAD-WINGED SKIPPER, is the largest species of the subfamily Hesperiinae in the northeastern United States, but its life history and distribution have until recently remained no better known than they were when it was described in 1865. Laurent (1908) was unable to rear larvae from western New York ova. The first significant biological information was published by Kendall in 1966. Ten years ago I began observing a large population at Philadelphia, Pennsylvania, and since 1966 have been able to compare it in various respects to several smaller populations in central and western New York. Examination of long series and of the scanty literature, and corerspondence with persons acquainted with the insect, confirm the field studies in suggesting that the Atlantic Coastal Plain populations of *P. viator* are subspecifically differentiated from those located near the Great Lakes.

It is unfortunate that Edwards's types apparently included both subspecies (Edwards, 1865). His description is based on one of each sex; a male "taken by Arthur Christie in northern Illinois," figured on his plate 1, fig. v, and a female collected by Norton at New Orleans, and not figured. The figured male is clearly of the Great Lakes subspecies. Holland (1931) figured as the "types" of *viator* two specimens from the Edwards collection in the Carnegie Museum, which have been identified by H. K. Clench as a male from Ontario and a female from Texas, and therefore "pseudotypes." The real types are at neither the Carnegie Museum nor the American Museum of Natural His-

[1] Present address: Division of Science and Engineering, Richmond College, 50 Bay Street, Staten Island, New York 10301.

tory, and must be assumed lost. The Coastal Plain subspecies of *P. viator* is better known than the Great Lakes one, but Edwards based his description almost entirely on the Illinois male; the Great Lakes subspecies should thus be taken as the nominate one. It seems desirable to fix this usage through a neotype designation. Strangely, until 1969 the only Illinois record of *P. viator* was Christie's original male; no specimens could be found in the American Museum, Carnegie Museum, United States National Museum, Cornell University, Museum of Comparative Zoology (Harvard), Field Museum of Natural History, or Illinois Natural History Survey collections. Through the kindness of Roderick R. Irwin of the I.N.H.S. an authentic pair of Illinois *P. viator* has been located, and I designate the male as neotype of *Poanes viator* Edwards and therefore of the nominate subspecies. This specimen has the postmedial spots of the hindwing beneath better developed than most *P. v. viator*, but the female taken with it is more "typical."

Neotype.—A male deposited in the Illinois Natural History Survey bearing the manuscript label "Goose Lake Prairie / Grundy Co. Ill. / 28-vii-69 / E. D. Cashatt" (fig 1, a, c). I have added a label identifying the specimen as the neotype of *P. viator.* Grundy County is in northwestern Illinois. A female with identical data (fig. 1, b, d) is also in the I.N.H.S. collection.

Poanes v. viator should be understood to apply to all the inland populations around the Great Lakes from central New York on the east to eastern North and South Dakota on the northwest and eastern Nebraska on the southwest (Shapiro, 1970). The Coastal Plain subspecies is here designated:

Poanes viator zizaniae, new subspecies

(figure 2, a-j)

Holotype male (fig. 2, e) — Expanse, 33.0 mm. Length of left forewing, 19.9 mm. Upper surface dark brown marked with golden yellow as figured. Lower surface of forewings golden brown, suffused with blackish brown below vein M_3, but paler at the outer margin; spots golden yellow, a blackish-brwn dot at end of cell. Lower surface of hindwings golden brown with a large dull yellow blotch consisting of four spots: a small one in the middle of cell RS; one in cell M_1 filling the middle third, just enclosing a dot of the ground color at its basal end; one nearly filling the basal half of cell M_3; and one in cell Cu_1,

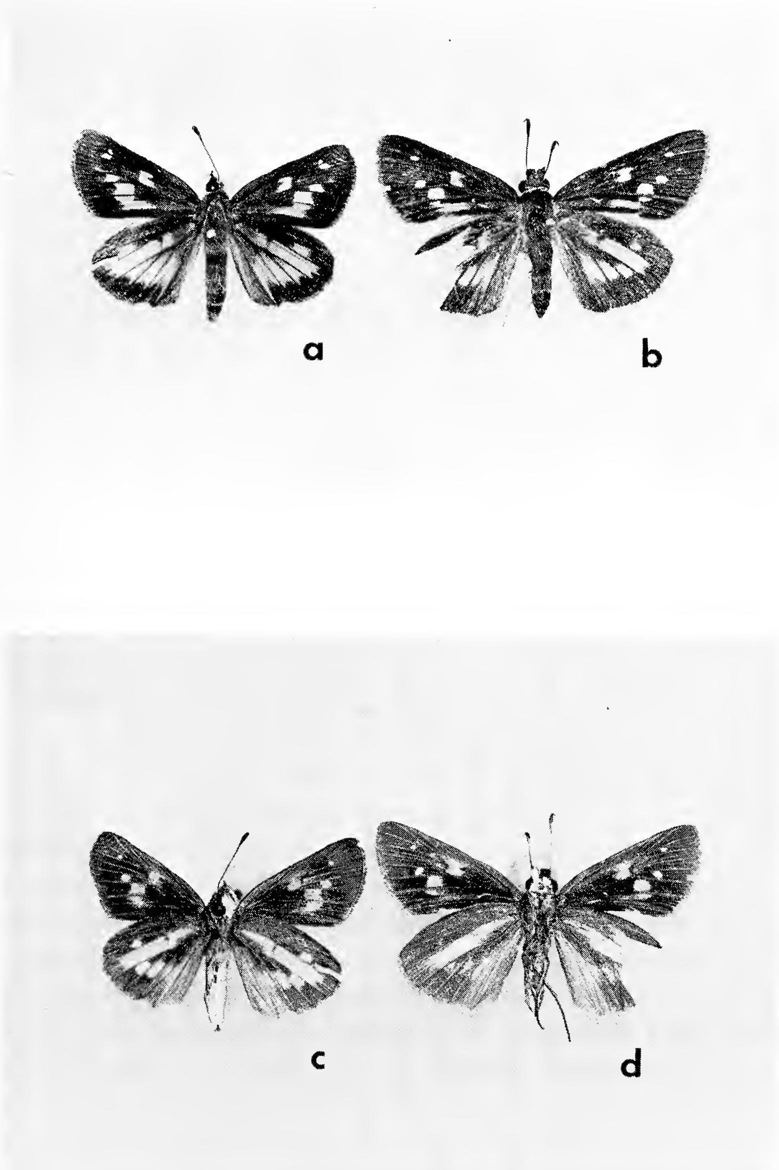


Fig. 1—a, c: *Poanes viator viator*, neotype ♂, Goose Lake Prairie, Grundy Co., Ill., vii.28.69. b, d: ♀, same data.

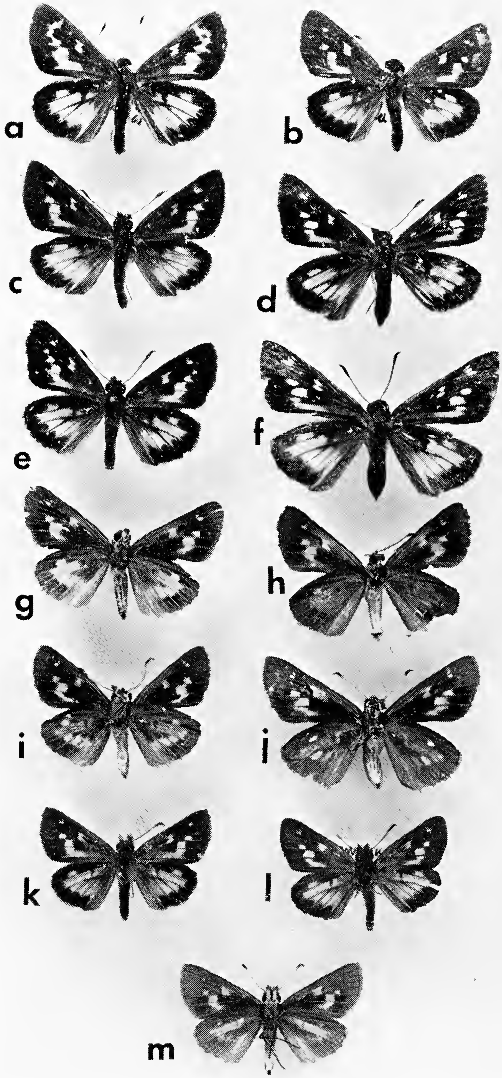


Fig. 2. a-j—*Poanes viator zizaniae* from Tinicum Wildlife Preserve, Philadelphia, Pa. a, paratype ♂, vii.20.65; b, paratype ♂, vii.20.65; c, paratype ♂, vii.16.66; d, allotype ♀, vii.16.65; e, holotype ♂, vii.16.65; f, paratype ♀, vii.20.65; g, "light" paratype ♂, vii.16.65; h, "dark" paratype ♂, vii.16.65; i, "intermediate" paratype ♂, vii.20.65; j, paratype ♀, vii.9.66. k-m: *Poanes v. viator*, Tamarack, Clinton Co., Pa. vii.19-20.65, 3 ♂.

extending from 1/5 the distance distad to the middle. Anal area paler than the ground color, with a pale shade extending to the base. Fringes, body and appendages as in the nominate subspecies.

Allotype female (fig. 2, d). — Expanse, 40.0 mm. Length of left forewing, 22.7 mm. Upper surface of forewings dark brown with lighter spots as in the nominate subspecies, as figured: those above Cu_1 white, that in cell Cu_1 white tinged with yellow, and the elongate spot in cell Cu_2 golden yellow, especially the part below the trace of A_1. Upper surface of hindwings dark brown, the discal area golden yellow. Lower surface of forewings dull brown, vaguely greenish, suffused in the same pattern as the male, the spots golden yellow except the two subapical dots nearly white. Lower surface of hindwings golden brown, vaguely greenish, the pattern as in the male but olivaceous buff, not contrasting. Fringes, body and appendages as in the nominate subspecies.

Holotype male: Tinicum Wildlife Preserve, Philadephia County, Pennsylvania, vii.16.65, *leg.* A. M. Shapiro. *Allotype female*: Same data. Both types deposited in Cornell University. *Paratypes*: 99 males and 27 females as follows: from the Tinicum Wildlife Preserve, Philadelphia: 25♂ 5♀, vii.22.67; 15♂ 2♀, vii.16.66; 16♂ 12♀, vii.20.65; 4♂ 3♀, vii.9.66; 27♂ 3♀, vii.16.65; 2♂ 2♀, vii.23.66; all *leg.* A. M. Shapiro. Also 10♂, Guadalupe County, Texas, iv.9.67, *leg.* R. O. Kendall. Paratypes will be distributed among the American Museum of Natural History, the Academy of Natural Sciences of Philadelphia, Cornell University, the Carnegie Museum, and the United States National Museum. Specimens of the new subspecies, mostly from New Jersey and the New York City area, are numerous in the collections of the major eastern museums. Additional topotypical material is in the private collections of Mr. George Ehle of Lancaster, Pa. and Mr. Joseph Smaglinski, Reading, Pa.

Poanes viator zizaniae is named for its foodplant, being the genitive of *Zizania* L. The name applies to all populations from coastal New England to Texas, east of the Appalachian Mountains (figure 3).

The two subspecies differ in size and pattern, but no significant differences were found among the genitalia of males from Tinicum, Texas, and western New York.

The length of the left forewing (LFW) was compared for random samples collected in Pennsylvania colonies of both subspecies (Table 1):

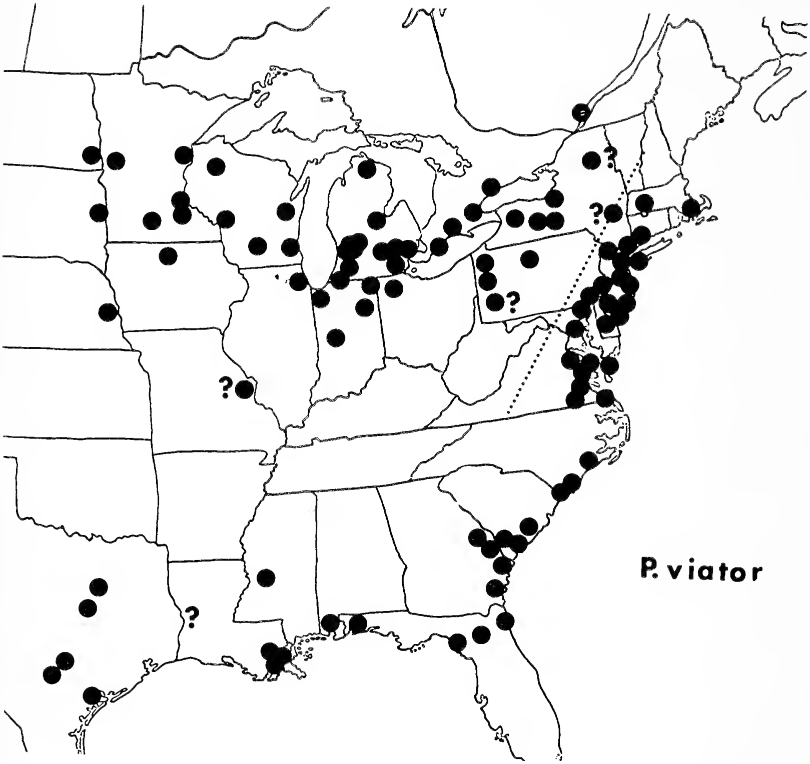


Fig. 3.—Distribution of *Poanes viator*. Dotted line separates Coastal Plain *P. v. zizaniae* from inland *P. v. viator*.

Table 1

	P. v. viator[a]		*P. v. zizaniae*[b]	
	♂	♀	♂	♀
N =	24	12	25	6
LFW =	15.90 mm	19.70 mm	19.44 mm	21.70 mm.
s.d. =	0.46	0.61	0.58	1.08

[a]Tamarack, Clinton Co., Pa., vii.19-20, 1965

[b]Tinicum Wildlife Preserve, Philadelphia Co., Pa., vii.22-67.

Using a standard t-test (Snedecor, 1940), these means differ at the .01 level in each sex. This difference holds equally well for all populations for which a reasonable sample has been seen, and was first remarked for a series from Lanoraie, Quebec, described by Forbes (1960) as a "pauperized race." This series (in the Canadian National Collection) has been examined and is not significantly smaller than specimens from western and central New York.

The few Nebraska specimens seen, collected by Leussler, are larger than other *P. v. viator* but have the same pattern on the hindwing beneath. They differ from all other populations in consistently having yellow spots in cells M_1 and M_2 of the forewing above. This character occurs with relatively low frequency in populations of both subspecies; it is infrequent (less than 5%) at Tinicum. Texas specimens are slightly smaller than other *P. v. zizaniae* but have the underside pattern of that subspecies.

In *P. v. zizaniae* the blotch in the middle of the hindwing beneath is relatively broad; the postmedial spots are well developed, longer (basal-distal) than wide; the elongate yellow spot in M_1 is cut off squarely just basad of the included dark submedial dot, and never reaches the base. In *P. v. viator* the postmedial spots are small, indistinct, and usually rounded; the spot in M_1 is longer and more contrasting, reaching as a pale shade to the base (fig. 2, m). A few specimens lack the postmedial spots but have the spot in M_1 a yellow streak from the base nearly to the margin. The usual pattern produces an effect similar to that of the same wing in *Euphyes dion* Edwards and *Poanes howardi* Skinner. *P. v. viator* often occurs with *E. dion* and may be difficult to tell from it in the field.

Forbes (1960) notes that the hindwing blotch beneath may be either "weak" or "contrasting". Male *P. v. zizaniae* divide easily into three grades based on this character (fig. 2, g-i). The female pattern (fig. 2, j) is more obscure, and mono-

Fig. 4.—The habitat of *Poanes viator zizaniae* in the Tinicum Wildlife Preserve, Philadelphia, Pa., vii.27.66. *Zizania* forming solid stand in background.

morphic. Every Coastal Plain series examined, including Texas, is trimorphic in the male. A random sample of 94 Tinicum males taken in 1966 included 25 "dark" (0.27), 41 "intermediate" (0.44), and 28 "light" (0.30). If the three grades represented the genotypes produced by a single allele pair with frequencies of 0.5, these figures would very closely approximate the Hardy-Weinberg equilibrium values. The genetics of the polymorphism is, of course, totally unknown. The three grades, "dark," "intermediate," and "light," roughly correspond phenotypically to *Poanes massasoit* Scudder forms *suffusa* Laurent, *hughi* Clark, and typical, respectively. Similar phenotypes occur in *P. yehl* Skinner (Mather and Mather, 1958) and *P. hobomok* Harris. In *P. massasoit* and *P. hobomok* the three grades often do not occur together in the same populations, suggesting they are not allelic. The genus *Poanes* is often considered polyphyletic (cf. Klots, 1951). The holotype of *P. v. zizaniae* belongs to the "intermediate" grade.

A few male *P. v. zizaniae* have the blotch beneath very clear yellow and of the same shape as in *P. hobomok.* Such males also have the light markings enlarged above, frequently including the light spots in cells M_1 and M_2 of the forewing (fig. 2, a).

The phenotype of *P. v. viator* is essentially monomorphic. Nothing like the "dark" form has been seen in this subspecies. Rarely the long spot in cell M_1 is tinted slightly reddish.

BIOLOGY

Food Plant. — At Tinicum and Bombay Hook, Delaware, *P. v. zizaniae* feeds on wild rice, *Zizania aquatica* L. (Gramineae). In Texas, Kendall (1966) found it on the closely related grass marsh millet, *Zizaniopsis miliacea* (Michx.) Doell. & Arch. The geographic range of *Z. aquatica* alone (Hitchcock, 1935) includes the entire range of *P. v. viator,* but it may have been introduced to much of this area by the Indians. *Zizania* has a disjunct eastern North American-eastern Asia (Arcto-Tertiary relict) distribution (Fernald, 1950), probably having survived the Pleistocene in the southeast. There is no evidence that *P. v. viator* ever feeds on *Zizania,* and it is often found in places where this plant does not grow. Miller (1961) found it associated with an undetermined bog sedge in north-central Iowa. In New York and Pennsylvania it and *Euphyes dion* are both associated with and oviposit on *Carex lacustris* Willd. (*Carex riparia,* var. *lacustris,* of authors). This was reported by Heitzman (1964) as a food of *E. dion* in the Midwest. It is also a

food plant of *Lethe appalachia* Chermock (Satyridae) (Shapiro and Cardé, 1970). Both Fernald (1950) and Wiegand and Eames (1926) record this sedge from shallow water in circumneutral to alkaline marshes, but it also occurs in acid waters; its role in Minnesota bogs is described by Conway (1949). Its range is given by Fernald as "Anticosti I., Quebec to S. Manitoba, south to Nova Scotia, New England, Virginia, Ohio, Indiana, Illinois, Iowa, and South Dakota." This resembles the range of *P. v. viator*, excluding only Nebraska.

Pre-oviposition behavior by female *P. v. zizaniae* directed toward reed, *Phragmites communis* L., has been observed twice at Tinicum, but no eggs could be found. *Phragmites* is suspected as a food plant of this subspecies in Connecticut (C. L. Remington and R. T. Cardé, pers. comm.). It is acceptable to large larvae taken from *Zizania*, but newly hatched larvae have not been tested. *Phragmites* is believed to be non-native to North America.

Large larvae of *P. v. zizaniae* are easily found on the food plant at Tinicum. The larva of *P. v. viator* has not been collected in the wild.

Habitat. — Poanes viator zizaniae usually occurs in fresh to brackish marshes in which the food plant, *Zizania*, forms extensive stands in shallow water; such habitats have been described in Virginia (Clark and Clark, 1951) and Georgia (L. Harris Jr., pers. comm.) as well as in Pennsylvania and New Jersey (Shapiro, 1966). The vegetation of the Tinicum marsh is described by McCormick (1970); this is the largest remnant (about 400 acres) of the tidal marshes of the Delaware, which once extended from the lower bay to Bristol, Pa. and whose vegetation was described by Smith (1867) and Harshberger (1904). *P. v. zizaniae* occurs mostly in the true marsh near *Zizania*, (fig. 4), but visits flowers freely—often well away from the food plant, particularly in the males. Species often visited are pickerelweed, *Pontederia cordata* L.; purple loosestrife, *Lythrum salicaria* L.; blue vervain, *Verbena hastata* L.; and buttonbush, *Cephalanthus occidentalis* L. Species common in *P. v. zizaniae* habitats, but not visited, are swamp rose-mallow, *Hibiscus moscheutos* L., and primrose-willow, *Jussiaea repens*.

The habitats of *P. v. viator* are frequently much less open and extensive. Miller found it in an overgrown, sedgy peat bog in Iowa. Sheppard (pers. comm.) found it at Lanoraie, Quebec in

a "willow swamp with sedges" and Holmes (pers. comm.) in a "small marsh . . . among the rushes" at Brantford, Ontario. Its New York and Pennsylvania habitats are mosaics of relatively open sedge marsh and dense bush swamp. Some characteristic plant associates are poison sumac, *Rhus vernix* L.; winterberry, *Ilex verticillata* (L.) Gray; alder, *Alnus* spp.; swamp milkweed, *Asclepias incarnata* L., and Joe-Pye weed, *Eupatorium* spp. The now-extinct Ithaca colony, destroyed by flood control dredging and filling in 1968, was located in a two-acre *Carex lacustris-Typha* marsh heavily overgrown with willow and tall herbs on the drier sites. It was a relict of the once extensive sedge-cattail marshes at the mouth of Cayuga Inlet. *P. v. viator* still occurs in the relatively undisturbed marshes at Monetzuma, New York, at the north end of Cayuga Lake.

Flight Period — *P. v. zizaniae* at Tinicum flies just before the middle of July through early August, peaking about July 20. This single, short flight corresponds to other northern Coastal Plain records (Comstock, 1940; Davis 1910; Beutenmuller 1893, 1902; Forbes, 1928). The Clarks (1951) give a confusing picture for Virginia. At most localities they find no evidence of more than one flight, but the dates for the entire state divide into two groups: June 6-July 5 and July 25-September 2. In Richmond County the species was found on June 27, 1937 and August 31, 1941 at the same locality. Probably *P. v. zizaniae* is bivoltine in coastal Virginia and the uncertainties reflect only inadequate collecting. This is certainly true in Georgia, where Harris (pers. comm.) records it from late April-late May and late September-early November, again not in the same localities. There should be a midsummer brood as well. Florida records (Kimball, 1965) are fragmentary: April and August. Kendall (1966) records four broods in eastern Texas.

P. v. viator is single-brooded everywhere, including Nebraska (Leussler, 1939). The flight is mainly in July. In Central New York it begins a bit earlier than Coastal Plain *P. v zizaniae* farther south (as early as July 3 at Ithaca) and extends into early August (August 3, Texas Hollow, Schuyler County).

Population Structure. — The Tinicum colony of *P. v. zizaniae* was studied by the Lincoln index mark-recapture method (cf. Ford, 1957) to obtain an estimate of population size in 1965 and 1967. The insects are easily captured and generally well suited to capture-recapture study. The resulting values were 12,000-15,000 in 1965 and 4,000-6,000 in 1967. Most populations

of *P. v. viator* are much sparser than this; of the upstate New York colonies, only Montezuma and the Oak Orchard Swamp have large enough populations to make similar studies feasible. The sparseness of these populations may be due to the nature of the habitat, but interspecific aggression by territorial male *Euphyes dion* against the non-territorial *P. v. viator* males and females was frequently observed, and may be a significant factor in limiting their population density. Since both species feed on the same sedges, it may also be relevant to competition for oviposition sites or larval food, but almost nothing is known of the nature or even the reality of such competition in butterflies (Clench, 1967).

Adult Behavior. — Both subspecies of *Poanes viator* are non-territorial. In this they resemble other marsh and bog butterflies such as *P. massasoit* and *Lycaena epixanthe* Boisduval and Le Conte. Such species occur in a sharply defined habitat, often at high densities, while their more wide-ranging, ecologically tolerant relatives (e.g. *Poanes hobomok* and *Lycaena phlaeas* Linnaeus) are less concentrated spatially and show male territoriality. *Euphyes dion* and *E. bimacula* Grote and Robinson are marsh butterflies which are territorial and normally maintain sparse populations despite the circumscribed nature of their habitat. During a population outbreak of *E. bimacula* in central New York in 1968, this behavior was suppressed (Shapiro, unpublished). *E. dion* rarely exceeds a population density of two pairs per acre in upstate New York.

Both subspecies of *P. viator* seem to display intrinsic barriers to dispersal (Ehrlich, 1961). Although males and, less frequently, females may leave the vicinity of the larval food plant to feed, neither sex has been observed out of (human) sight of the areas of highest population density. Actually dispersal data are unavailable because of the large distances separating the colonies observed. Estimates of movement among patches of suitable habitat within large mosaic areas such as the Montezuma marsh and the Oak Orchard Swamp may be obtainable. At Ithaca, *P. v. viator* failed to colonize seemingly suitable habitats within one-half mile of the now extinct Cayuga Inlet colony.

Both sexes usually fly below the top of vegetation, twisting among wild rice or sedge blades from one to three feet above the ground or water surface. Eggs are laid singly on the underside of a blade of the food plant, usually near the middle or below it; the female clings to the edge of the blade and curves

the abdomen underneath it to lay.

Larval Behavior. — Kendall (1966) reports that Texas larvae of *P. v. zizaniae* construct no formal shelter, living instead in the recess at the base of the leaf on which they feed. Tinicum larvae do reinforce this area with silk before molting. At least after the last molt, the larva frequently moves to a new leaf. It always feeds above the water line. Large larvae collected in late August pupate within two or three weeks and produce adults from ten to thirty days later. This is similar to Kendall's experience in Texas, where a larva collected 19 June pupated 24 June and eclosed 2 July. Obviously, this is not the normal developmental rate at Tinicum.

Zizania is an annual which dies before hard frost, and later falls over in the water. By September 15 no trace of larvae can be found on the plants, nor have larvae or pupae been found in the *Zizania* remains in midwinter. Apparently the larvae leave the stand when mature; if they overwinter on land they must be capable of swimming or rafting a distance of at least a few hundred yards. Kendall found summer pupae in the larval nests, but does not know how the species overwinters in Texas.

SUMMARY

1. *Poanes viator* Edwards is divided into two subspecies, *P. v. viator* and *P. v. zizaniae,* new subspecies.

2. *P. v. viator* is restricted to the sedge-feeding populations distributed around the Great Lakes from central New York to Nebraska, characterized by smaller size, monomorphic ventral hind wing pattern, and univoltinism.

3. *P. v. zizaniae* (type locality Tinicum Wildlife Preserve, Philadelphia, Pa.) is distributed on the Atlantic Coastal Plain from New England to Texas. It feeds on *Zizania* (and possibly *Phragmites*), is larger than *P. v. viator,* has a trimorphic ventral hind wing pattern in males, and is multivoltine from Virginia south.

ACKNOWLEDGMENTS

Many individuals and institutions contributed to this investigation by providing records or making specimens available for study. I wish to thank: the late R. G. Beard; F. M. Brown; R. T. Cardé; H. K. Clench (Carnegie Museum); C. V. Covell,

Jr.; M. G. Emsley (Academy of Natural Sciences of Philadelphia); W. D. Field (U.S. National Museum); T. N. Freeman (Canadian National Collection); J. M. Fogg, Jr. (University of Pennsylvania Herbarium); D. F. Hardwick (Canadian National Collection); L. Harris, Jr.; R. Heitzman; A. M. Holmes; R. Irwin (Illinois Natural History Survey); R. O. Kendall; C. P. Kimball; A. B. Klots (American Museum of Natural History); B. Mather; L. D. Miller; Col. S. S. Nicolay; L. L. Pechuman (Cornell University); N. D. Riley (British Museum — Natural History); J. C. E. Riotte (Royal Ontario Museum); A. C. Sheppard; M. E. Smith (University of Massachusetts); J. Wilcox (New York State Museum).

LITERATURE CITED

BEUTENMULLER, W. 1893. Descriptive catalogue of the butterflies found within fifty miles of New York City. *Bull. Amer. Mus. Nat. Hist.* 5: 241-310.

________, 1902. The butterflies of the vicinity of New York City. Guide leaflet 7, suppl. to Amer. Mus. Journal, v. 2.

CLARK, A. H. and L. F. CLARK. 1951. Butterflies of Virginia. *Smithson. Misc. Coll.* 116(7): 239 pp.

CLENCH, H. K. 1967. Temporal dissociation and population regulation in certain Hesperiine butterflies. *Ecology* 48: 1000-1006.

COMSTOCK, W. P. 1940. Butterflies of New Jersey. *J. New York Ent. Soc.* 48: 47-84.

CONWAY, V. M. 1949. The bogs of central Minnesota. *Ecol. Monog.* 19: 175-225.

DAVIS, W. T. 1910. List of the Macrolepidoptera of Staten Island, New York. Proc. Stat. I. Assn. Arts Sci. 3: 1-30.

EDWARDS, W. H. 1865. Description of certain species of diurnal Lepidoptera found within the limits of the United States and British America. IV. *Proc. Ent. Soc. Phila.* 4: 201-204.

EHRLICH, P. R. 1961. Intrinsic barriers to dispersal in checkerspot butterfly. *Science* 134: 108-109.

FERNALD, M. L. 1950. Gray's Manual of Botany. Eighth edition. New York: American Book Co. 1632 pp.

FORBES, W. T. M. 1928. Lepidoptera. *in* W. D. Leonard, ed. A list of the insects of New York. *Cornell Univ. Agr. Expt. Sta., Mem.* 101. pp. 532-687.

________, 1960. The Lepidoptera of New York and neighboring states. IV. *N. Y. State Agr. Expt. Sta. Mem.* 371: 188 pp.

FORD, E. B. 1957. Butterflies. Third edition. London: Collins. 368 pp.

HARSHBERGER, J. W. 1904. A phyto-geographic sketch of extreme southeastern Pennsylvania *Bull. Torrey Bot. Club* 31: 125-159.

HEITZMAN, R. 1964. Season summary. *Lepid. Soc. News,* 15 April.

HITCHCOCK, A. S. 1935. Manual of grasses of the United States. *U.S. Dept. Agr. Mic. Publ.* 200: 1040 pp.

HOLLAND, W. J. 1931. The Butterfly Book. Revised edition. Garden City, N. Y.: Doubleday Doran. 423 pp., 77 pls.

KENDALL, R. O. 1966. Larval foodplants and distribution notes for three Texas Hesperiidae. *J. Lepid. Soc.* 20: 229-232.

KIMBALL, C. P. 1965. The Lepidoptera of Florida. Gainesville: State Dept. Agr. 363 pp.

KLOTS, A. B. 1951. A field guide to the butterflies. Boston: Houghton Mifflin Co. 349 pp.

LAURENT, P. 1908. Notes on the early stages of some *Pamphila*. *Ent. News* 19: 408-417.

LEUSSLER, R. A. 1939. An annotated list of the butterflies of Nebraska, with the description of new species. (Lepid., Rhopalocera). *Ent. News* 50: 34-39.

MATHER, B. and K. MATHER. 1958. The butterflies of Mississippi. *Tulane Stud. Zool.* 6: 64-109.

McCORMICK, J. 1970. The natural features of the Tinicum Marsh, Delaware and Philadelphia Counties, Pennsylvania, with particular emphasis on the vegetation. The Conservation Foundation.

MILLER, L. D. 1961. On nine Iowa butterflies, four new to the state. *J. Lepid. Soc.* 15: 97-98.

SHAPIRO, A. M. 1966. Butterflies of the Delaware Valley. Phila.: *Amer. Ent. Soc.* 79 pp.

————, 1970. Postglacial biogeography and the distribution of *Poanes viator* (Hesperidae) and other marsh butterflies. *J. Res. Lepid.*

SHAPIRO, A. M. and R. T. CARDÉ. 1970. Habitat selection and competition among sibling species of Satyrid butterflies. *Evolution* 24: 48-54.

SMITH, A. H. 1867. On colonies of plants observed near Philadelphia. *Proc. Acad. Nat. Sci. Phila.* 19: 15-24.

SNEDECOR, G. W. 1940. Statistical Methods. Third edition. Ames, Iowa. State College Press. 422 pp.

WIEGAND, K. M. and A. J. Eames. 1926. The flora of the Cayuga Lake basin, New York. *Cornell Agr. Expt. Sta. Mem.* 92: 491 pp.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

HABITAT — *YRAMEA CYTHERIS*

This Argynnid species inhabits the same general geographical area as *Colias vautieri,* both in Chile and Argentina. Shown here is the food plant, *Viola* sp., upper photo, growing among the rocks at Termas de Chillan, Province Ñuble, Chile, Dec. 22, 1970. The lower photo shows the general character of the Andes looking east to the Termas de Chillan (about 8,000 feet elevation).

W. Hovanitz

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

CONTENTS

Volume 8 *Number 1* *March, 1969*

Volume 8 *Number 2* *June, 1969*

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distributional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W. J. Reinthal and J. T. Mithell. Send data to Dr. W. J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U. S. A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P. O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P. O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W. T. M. Forbes. Entomological Reprint Specialists. P. O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B. M. Endicott. Distributed in U. S. A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P. O. Box 433, New York, N. Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A. I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

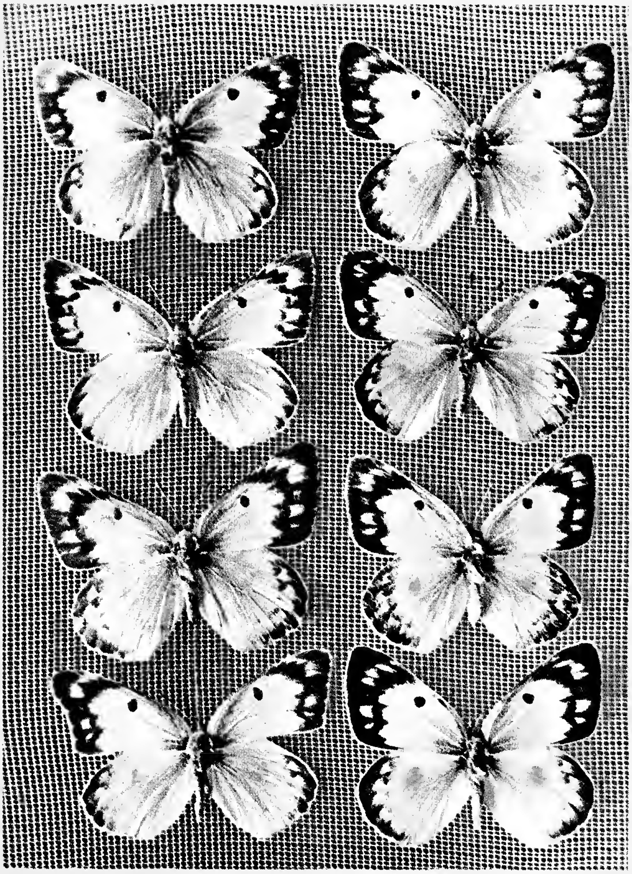
Centurie de Lepidopteres de L'ile De Cuba. P. H. Poey, 1832. C. W. Classey, 353 Hanworth Road, Hampton, Middlesex, U. K. in the U. S. A. Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 9 *Number 2* *June, 1970*

IN THIS ISSUE

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA



Volume 9 *Number 3* *September, 1970*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 9(3): 125-155, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

POSTGLACIAL BIOGEOGRAPHY

AND THE DISTRIBUTION OF *POANES VIATOR* (HESPERIIDAE) AND OTHER MARSH BUTTERFLIES

ARTHUR M. SHAPIRO[1]

Department of Entomology and Limnology, Cornell University
Ithaca, New York 14850

THE DISTRIBUTIONS OF MANY NORTH AMERICAN BUTTERFLIES and skippers are poorly known. In the course of a study of the biology of the Broad-Winged Skipper, *Poanes viator* (Edwards), it became clear that all published statements of the range were incorrect or inadequate; moreover, the actual distribution revealed by assembled data from collections, private collectors, and published sources was of a peculiar type virtually unreported for animals but well known for many years to botanists: the "Atlantic Coastal Plain-Great Lakes" disjunction. The ranges of several other poorly known species were then examined, and a repeating pattern emerged. This paper considers the nature and significance of that pattern.

THE RANGE OF *POANES VIATOR*

Edwards (1865) knew of only two localities for *P. viator*: northern Illinois and the vicinity of New Orleans. French (1885) gave "Gulf States, Massachusetts, New Jersey, Illinois, Wisconsin." Scudder (1889) showed it continuously distributed in the Mississippi Valley. Klots (1951) gave the range as:

> Massachusetts, southern Ontario, Minnesota, and Nebraska, south to Alabama and Texas; records scattered, not from all states within this general area. (p. 249)

The range figured (Fig. 1) is quite different. It includes four records which are queried. The single record at St. Louis (Knetzler, 1912) has not been confirmed by a specimen, and a veteran Missouri collector, Richard Heitzman, has never seen the species there. Forbes (1928) lists *P. viator* from Mount Marcy, New York, the highest peak in the Adirondacks—a seemingly unlikely habitat, and no specimen has been found.

[1] Present address: Division of Science and Engineering, Richmond College, 50 Bay Street, Staten Island, New York 10301.

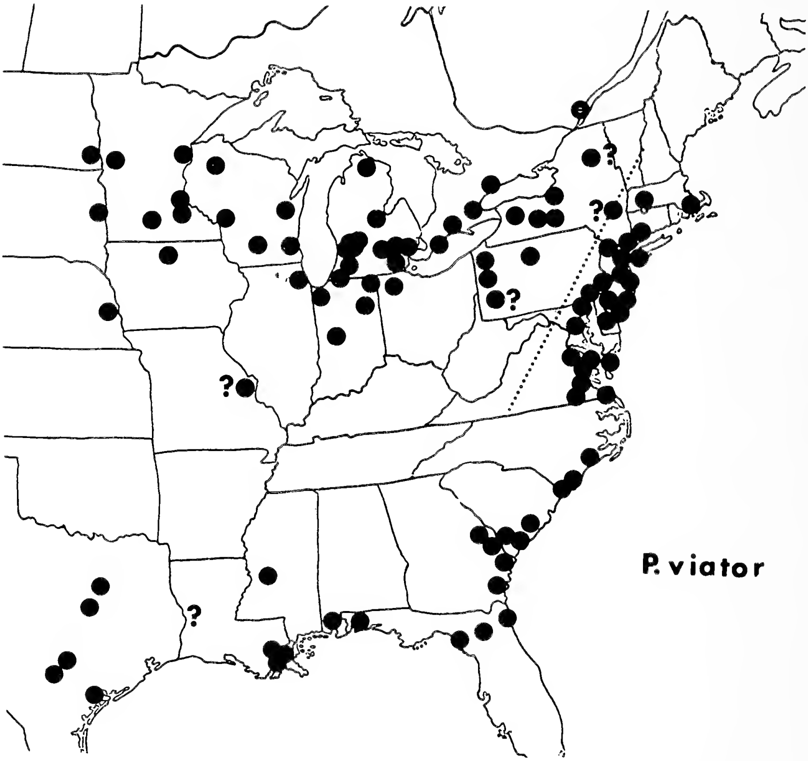


Fig. 1.—Distribution of *Poanes viator*. Dotted line shows western limits of *P. v. zizaniae*.

Chermock's record from Pittsburgh, Pa. (Tietz, 1952) is unverified, and there are no other southwestern Pennsylvania records. Bailey (1877) recorded *viator* from the sand plain at Karner, Albany County, New York. This is probably an accurate record, but no one has found the species since. It does not appear in the long series of Albany skippers at the New York State Museum, but many old specimens have been destroyed or discarded for lack of data. If a population once existed at Karner it was presumably the Coastal Plain subspecies, *P. v. zizaniae* Shapiro. One record omitted from the map is the Missouri Ozarks (Sell, 1916), given in a list including at least eight misdeterminations or falsifications.

The actual range thus divides neatly into the Coastal Plain element, *zizaniae,* from Massachusetts to Texas, and a Great Lakes element, nominate *viator,* from near Montreal to Nebraska and South Dakota. These two areas are separated by a narrow zone along the Appalachians in Pennsylvania and New York in which neither subspecies occurs. The same type of distribution in plants has led to repeated discussion of the origins of the "Coastal Plain element" in the Great Lakes flora (Peattie, 1922; McLaughlin, 1932; Cushing, 1965). Plant geographers usually interpret such disjunct distributions in terms of range changes following the last (Wisconsin) glaciation.

TYPES OF COASTAL PLAIN SPECIES

The Coastal Plain (Fig. 2) is clearly demarcated as a physiographic province by the character of the topography and the nature of the soils and underlying materials. At a given latitude, differences in vegetation occur across the Fall Line (cf. Hitchcock and Standley, 1919). Many species of plants and butterflies occur generally across the Fall Line, but other species may be considered of primarily Coastal Plain distribution. McLaughlin (1932) divided the plants into five groups, four of which are also represented among the butterflies:

1. Species and subspecies (other than salt marsh obligates) wholly restricted to the Coastal Plain: *Cercyonis pegala pegala* Fabricius, *Lethe portlandia portlandia* Fabricius, *Papilio palamedes* Drury, *P. troilus ilioneus* Abbot and Smith, *P. glaucus australis* Maynard, *Mitoura hesseli* Rawson and Ziegler.

2. Coastal Plain species and subspecies which also occur more or less frequently northward and westward, but generally near the Fall Line (the restriction becoming more severe north-

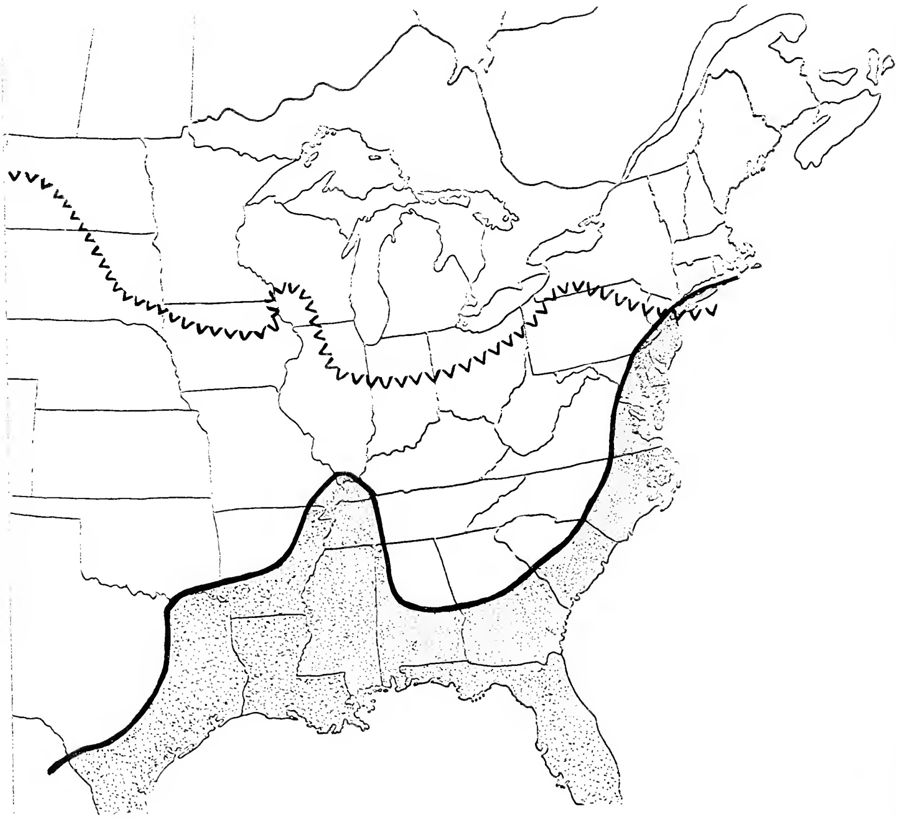


Fig. 2.—The Atlantic Coastal Plain (stippled) and the southern limits of the Wisconsin glaciation.

ward): *Euptychia areolata* Abbot and Smith, *E. hermes sosybia* Fabricius, *Phyciodes phaon* Edwards, *Erynnis horatius* Scudder and Burgess, *Wallengrenia otho* Abbot and Smith, and (as migrants) *Precis coenia* Hubner and *Phoebis sennae eubule* Linnaeus.

3. Widespread northern species penetrating southward farther on the Coastal Plain than inland: *Incisalia augustinus* Westwood, *I. polios* Cook and Watson, *Lycaena epixanthe* Boisduval and Le Conte, and the (genetically determined) *"lucia"* form of *Lycaenopsis pseudargiolus* Boisduval and Le Conte.

4. Species occurring more or less generally on the Coastal Plain, and disjunctly around the Great Lakes: *Poanes viator, P. massasoit* Scudder, *Euphyes dion* Edwards, *E. conspicua* Edwards. *E. dukesi* Lindsey, *Euptychia mitchellii* French, and *Pyrgus communis* Grote.

5. Coastal Plain species with close relatives endemic in the Great Lakes region. We have no butterfly species pairs strictly fitting this category, but the pairs *Euptychia areolata-E. mitchellii* and *Euphyes dion-E. alabamae* Lindsey are related to it; see below.

Differences in the extent to which Coastal Plain species and subspecies are distributed inland depend on two factors: suitability of inland areas for successful colonization and the ability of the species to reach them, both by short-term dispersal and long-term range changes. Cushing (1965) has rightly noted that that the range of each species is the result of its own unique history and biological properties. Treating species with superficially similar ranges as a unit with a common history may obscure important differences among them. Some of the Coastal Plain obligates, such as *Mitoura hesseli,* are obviously limited by the distributions of their food plants; others are not. The species in categories 3 and 4 above both seem to form ecologically defined units. At least three of the four species in category 3 are Ericaceous feeders and their distribution reflects the extent of acid barrens and bogs on the Coastal Plain.

All of the species in category 4 except *Pyrgus communis* are limited to marshes, feed on sedges (Cyperaceae) or (some populations) grasses (Gramineae), and, at least northward, are univoltine in midsummer. As will be shown below, all of the other eastern North American butterflies (except Florida endemics and the subarctic Satyrids) with these same characteristics have distributions closely related to the Coastal Plain-Great Lakes one, while few other species do. Moreover, these

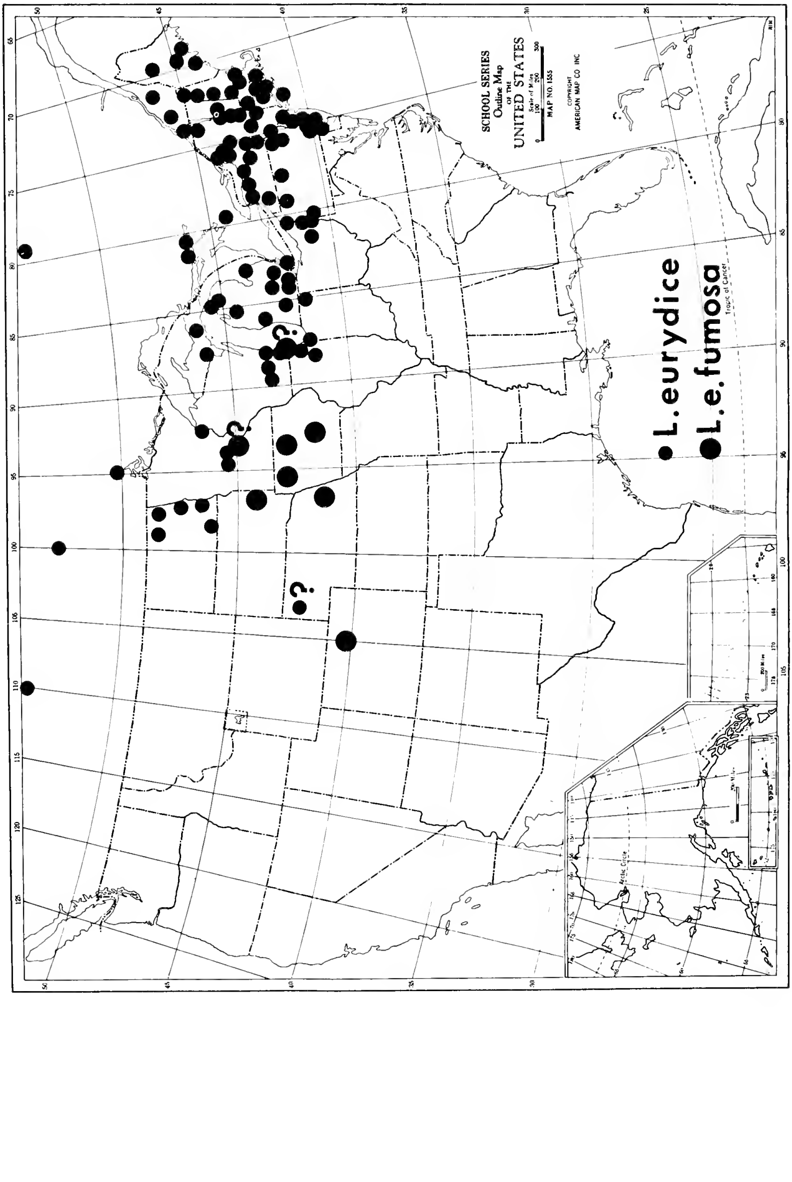


Fig. 3.—Distribution of *Lethe eurydice* subspecies.

six species all tend to be highly localized, and are not active colonizers today; their low vagility and the relative inaccessibility of their habitats make recent range extensions through human interference unlikely. The historical basis for category 4 distributions is, however, much less obvious than that for category 3.

THE COASTAL PLAIN-GREAT LAKES RANGES

The ranges falling in or related to this category involve various combinations of three areas: the northern and Mid-Atlantic portion of the Coastal Plain, the Gulf portion and lower Mississippi Embayment, and the Great Lakes region. They also entail various degrees of differentiation among the component populations.

Great Lakes-Northern Coastal Plain, nondisjunct. — *Lethe e. eurydice* Johansson (Fig. 3) is an example of a butterfly whose range extends continuously across the northeastern quarter of the United States, with no break in New York and (northern) Pennsylvania. It is a univoltine, *Carex*-feeding marsh species (Shapiro and Cardé 1970; Cardé, Shapiro, and Clench, 1970).

Great Lakes - Northern Coastal Plain, nondisjunct; southern Coastal Plain, disjunct. — The ranges of *Euphyes bimacula* Grote and Robinson (Fig. 4) might be considered similar to *L. eurydice* and likely to have a similar history, except for the two (widely separated) disjunct colonies far to the south (discussed and confirmed by Mather and Mather, 1958) and a specimen form Southern Pines, N.C., in the U.S. National Museum.

Great Lakes-Northern Coastal Plain, disjunct. — Superficially the range of *Euphyes conspicua* (Fig. 5) resembles that of *L. eurydice,* but it breaks in New York and Pennsylvania. I have visited many marshes in the critical area at the appropriate season without finding it. There are no phenotypic differences between eastern and western specimens, but Nebraska ones (*buchholzi* Ehrlich and Gilham) are larger and darker than others.

Poanes massasoit (Fig. 6) is nearly identical, except that a single isolated population occurs midway between the eastern and western ranges, in the Beaver Creek basin near McLean, New York (Shapiro, 1969, 1970a). Although the Lakes and Coastal Plain butterflies are virtually identical, Beaver Creek specimens differ consistently from them in phenotype (Fig. 7).

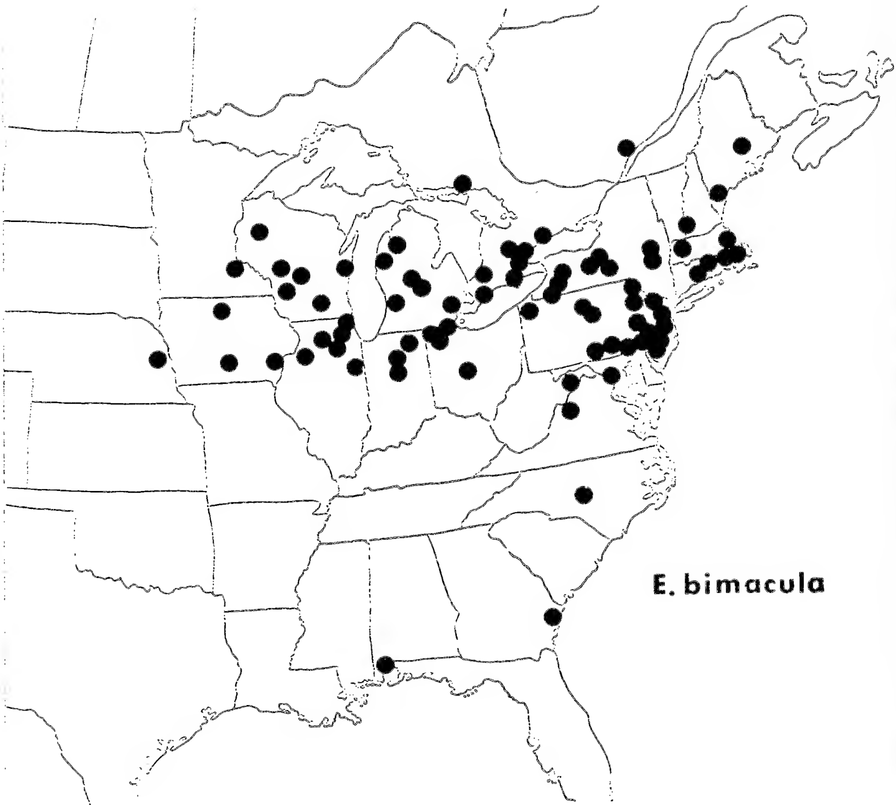


Fig. 4.—Distribution of *Euphyes bimacula.*

Great Lakes-entire Coastal Plain, disjunct. — The northern distribution of *Poanes viator* (Fig. 1) is almost identical to *E. conspicua*, but on the Coastal Plain it extends south and west to Texas. The populations are subspecifically differentiated. The grasshopper *Trimerotropis maritima* Harris has a similar distribution, except that its southern range does not extend west of west-central coastal Florida. The Lakes population extends from southern Ontario to southeastern Minnesota and northern Indiana, and is recognized as a subspecies (*interior* Walker). (See McNeill, 1902; Blatchley, 1920.)

Great Lakes-Northern Coastal Plain-Southern Coastal Plain, both disjunct. — *Euphyes dukesi* (Fig. 8) has the most extraordinary distribution of any North American butterfly, though the extremeness of its disjunctions has been lessened by the addition of data unknown to Mather (1963). The populations are not phenotypically differentiated.

Great Lakes-Northern Coastal Plain/Southern Coastal Plain, two species. — Mather (1965) noted that superimposing the Lake Michigan range of *Euptychia mitchellii* on a map of the closely related *E. areolata* gave a result reminiscent of the range of *Euphyes dukesi*. The recent rediscovery of *E. mitchellii* in New Jersey (Rutkowski, 1966) reinforces this impression; though the New Jersey colony is several miles above the Fall Line the relationship of this range to the others seems evident (Fig. 9). McAlpine, Hubbell, and Pliske (1960) suggested conspecificity of these two taxa.

Euphyes dion and *E. alabamae* (Fig. 10) present a similar case. Until recently considered conspecific, they are now known to be sympatric on the Coastal Plain from Maryland to South Carolina (recently reported from Florida by Clench, *in litt.*). I have been unable to find records, museum specimens, or colonies in the field to connect the central New York and Connecticut-New Jersey populations of *E. dion*, which are possibly slightly differentiated phenotypically.

POSTGLACIAL MIGRATION ROUTES AND CLIMATE

The very extensive literature on post-Wisconsin climate and biogeography can be summarized only very briefly here. Virtually all of the Great Lakes region was under ice at the Wisconsin maximum (Fig. 2). The ice sheets eradicated all plant and animal life in their paths, and displaced the biota southward in a basically zonal pattern complicated by geo-

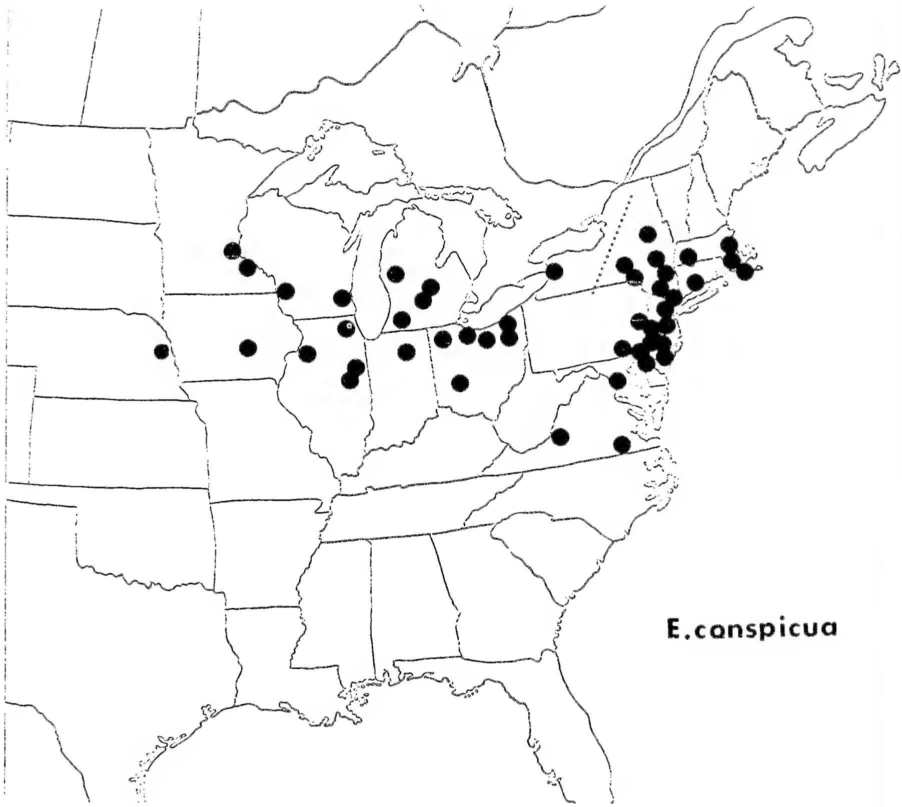


Fig. 5.—Distribution of *Euphyes conspicua*. Dotted line indicates disjunction in New York.

graphic factors and relict effects of earlier Pleistocene biotic migrations. After the ice retreated the biota returned northward. Our knowledge of post-Wisconsin climate and vegetation is largely inferred from pollen preserved in peat (Cushing, 1965; Davis, 1963, 1965). A fairly generally accepted chronology for post-Wisconsin climate in eastern and central North America, correlating well with that for western and central Europe, has emerged (cf. Cox, 1959; Cushing, 1965; Davis, 1965; Deevey, 1949; Dillon, 1956; Flint, 1947; Gleason, 1922; Smith, 1957; Terasmae, 1969). The disjunct ranges of our butterflies may be interpreted in terms of this chronology.

Euphyes bimacula affords clear evidence of the far southward displacement of northern species as a result of glaciation (not necessarily in the Wisconsin). The locations of the relict southern populations imply that a glacial refugium existed in the southeast. If modern populations were derived from those migrating northward from such a refugium, *E. bimacula* reached the Great Lakes *from the east.* How might it have done so?

As the glaciers retreated, they dammed up great amounts of water in the basins of the future Great Lakes. These bodies of water were drained as the region was uplifted by isostatic rebound behind the ice sheet (Taylor, 1915; King, 1965; Zoltai, 1969). While the St. Lawrence Valley was still blocked by ice, the Ontario basin discharged via the Mohawk Valley to the Hudson and thence to the Atlantic (Hough, 1958). The Hudson-Mohawk outlet probably existed between 12,500-10,500 B.P., providing a route for Coastal Plain organisms to reach the Great Lakes. Associated with the outlet, a nearly continuous band of marsh vegetation would have provided a corridor across New York State for the category 4 butterflies and others to colonize areas farther west. The opening of the St. Lawrence lowered the level of Lake Ontario, drying up the Mohawk Valley. Many of the populations of species now disjunct in New York may have become extinct at that time.

Euphyes bimacula and *Poanes viator* very probably followed this route from east to west; although *Poanes massasoit* and *Euphyes conspicua* have no southeastern populations today, they are also easily included in the model. The genus *Euphyes* is strongly eastern, with three endemic species in Florida and only one (the very wide-ranging *E. ruricola metacomet,* an old-field grass feeder) in the lower Mississippi Valley. *Poanes* is similarly eastern.

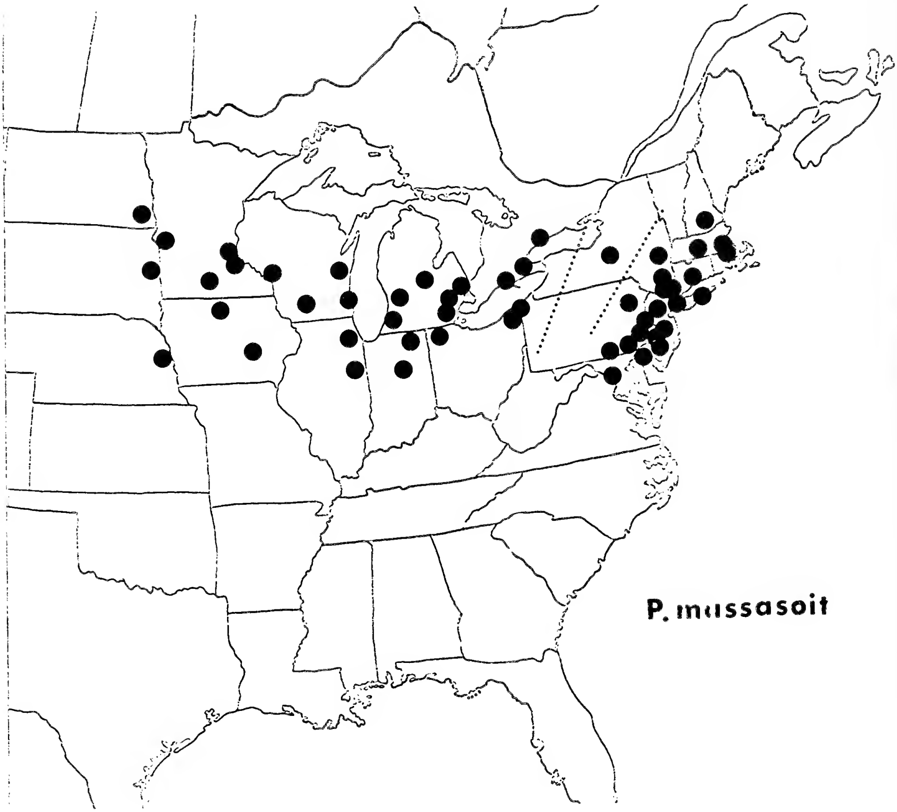


Fig. 6.—Distribution of *Poanes massasoit*. Dotted lines indicate area in which only one population (Beaver Creek) is known.

While the drainage pattern of the Great Lakes was changing, the climate warmed rapidly to a "climatic optimum" during which mesophytes such as elm, beech and hemlock displaced the spruce and pine which had followed the glaciers. About 5000 B.P., as reflected by a marked decline of hemlock in pollen profiles and a corresponding increase in oak, the climate began to dry and more xeric vegetation spread eastward, permitting western elements to enter the northeastern biota. Smith (1957) presents distributional evidence from reptiles and amphibians indicating penetration of western elements to the Altantic Coastal Plain in the DelMarVa peninsula. *Plebeius melissa samuelis* Nabokov (Fig. 11) presumably spread east at this time, reaching New England. About 2500 B.P. the climate was becoming cooler and more humid as it is today, and species which had invaded the northeast during the xerothermic interval declined as the mesic biota reasserted itself. Xerothermic relicts were left where soil or other local conditions permitted them to persist; *P. m. samuelis* is restricted to sandy soils (Shapiro, 1969). Cooler temperatures than prevailed before the xerothermic interval may have limited the dispersal of some of the mesic species.

Pollen profiles for several central and southern New York bogs show the xerothermic interval clearly as an oak-beech maximum and a very marked hemlock minimum (Cox, 1959). Cox and Lewis (1965) found a strong oak-hickory maximum in the profile for Crusoe Lake in central New York. This dry interval may have contributed to the extinction of remaining populations of marsh butterflies with disjunct modern distributions. The Beaver Creek colony of *P. massasoit* is in a basin which has undergone continuous bog development since the recession of the ice sheet (Cornell University, 1926; Cox, 1959).

An alternative hypothesis to the westward spread of Coastal Plain species to the Great Lakes is that they migrated northward up the Mississippi Valley, spreading from *west to east* into New York. This is probably true of *Lethe eurydice* (Cardé, Shapiro, and Clench, 1970). Some species might have moved northward via both routes, either merging in the northeast or never coming into contact, leaving the disjunction observed today.

McLaughlin (1932) shows that very few of the Coastal Plain-Great Lakes plants followed the Mississippi Valley route, but his explanation of this (that changes in course and climatic instability made the Mississippi floodplain at best an uncertain

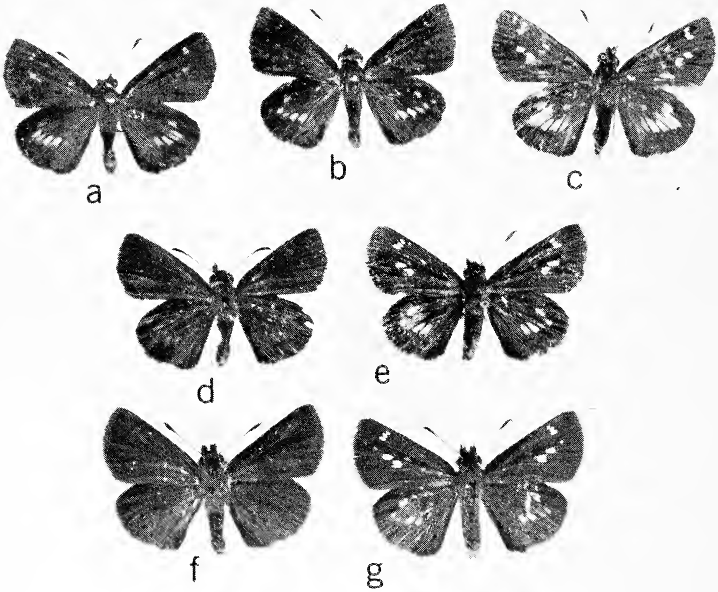


Fig. 7.—*Poanes massasoit*. a-c: Beaver Creek basin, Tompkins County, N.Y., vii.23.68 (a, b, ♂; c, ♀). d (♂) and e (♀): Rockland County, N.Y., vii.20.68. f (♂) and g (♀): Burlington County, N.J., 1964.

corridor) seems weak. Whatever the reason, there are no relict populations in the Mississippi Valley or the Ozarks to support this hypothesis for most of our butterflies. Even with the new Illinois data, *Euphyes dukesi* remains an ambiguous case and could have spread northward by either or both routes. *Problema byssus* Edwards (Fig. 12) clearly spread northward up the Mississippi Valley, but never reached the Great Lakes.

TWO ANOMALOUS RANGES

Hesperia metea Scudder (Fig. 13) seems to have migrated northward in both the Coastal Plain and the Mississippi Valley, but where did the seemingly isolated Michigan-Wisconsin population come from? This species occurs primarily in open sandy barrens in the northeast (Shapiro, 1965) and in open pine-oak woodland to the south and southeast, and would seem a likely candidate for east-west dispersal in the xerothermic. Yet there are apparently no populations between Tioga County, New York and Michigan. Several hypotheses can be constructed to account for this, but none is satisfactory given the amount of data at hand. The very short flight season makes it likely that the range of this species is still poorly known.

The Regal Fritillary, *Speyeria idalia* Drury (Fig. 14), shows a number of range anomalies. It is abundant on the prairies in Kansas and Nebraska in some years and also occurs in the Ozarks. Its distribution seems continuous along the south shore of Lake Erie, suggesting an eastward spread during the xerothermic interval. However, it extends south in the Appalachians at least to North Carolina, raising serious doubts as to whether the northeastern populations could have come from the west alone. Rather than spreading south in the mountains after the xerothermic, *idalia* may well have spread north in both the east and the west, becoming confined to higher elevations in the lower Appalachians as the climate warmed. The two northward advances would then have met in Pennsylvania or New York, if at all. *S. idalia* is conspicuously absent from the Finger Lakes and Mohawk Valley in central New York, though it extends up the Susquehanna drainage to Binghamton and also exists in the southwestern part of the state. It is possible that these populations are not in contact today and even that the western *idalia* never penetrated further into the northeast than southwestern New York.

S. idalia also occurs disjunctly in the eastern foothills of the Colorado Rockies. Like *Lethe eurydice fumosa* Leussler (dis-

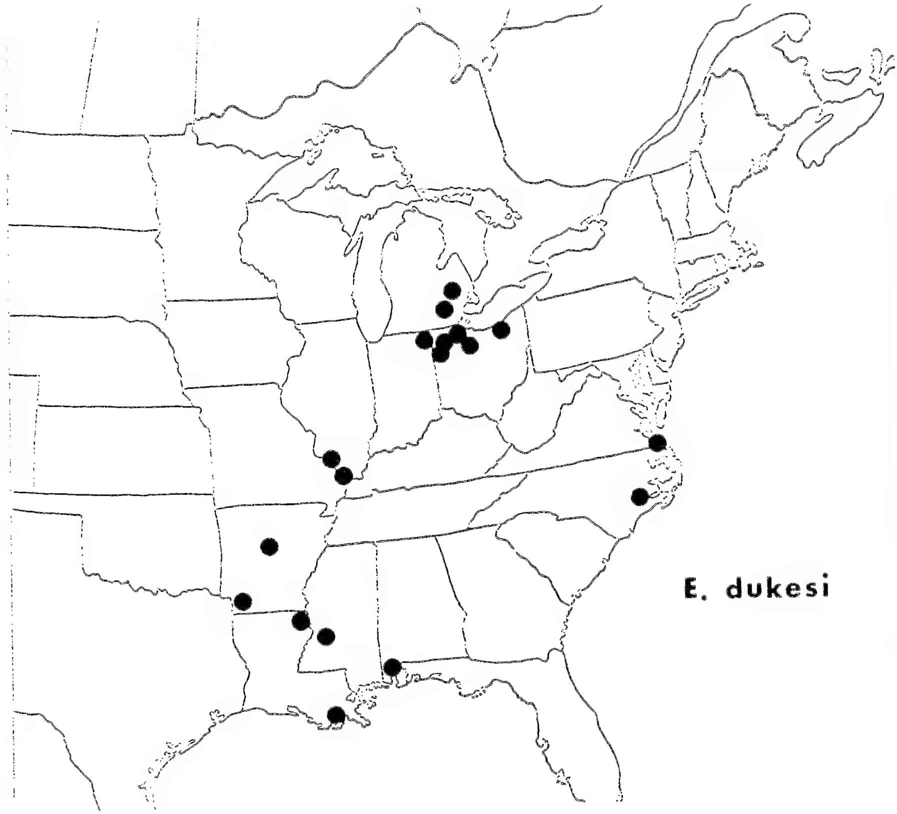


Fig. 8.—Distribution of *Euphyes dukesi.*

cussed below), it probably reached there during the climatic optimum and was stranded there when the western plains became appreciably drier at roughly the same time as *S. idalia* was spreading northeastward in the Ohio-Lake Erie area.

GENETIC DIFFERENTIATION

If the subspecific differences in *Poanes viator* arose after the closing of the Mohawk outlet, they have had some 10,000 generations in which to come about. The same can be said for the differentiation of the Beaver Creek population of *Poanes massasoit*. In this case, however, the entire modern population probably does not exceed 200 individuals in most years, and may be much less. The population is thus susceptible to rapid change by either natural selection or genetic drift.

None of the species pairs can be dated with any certainty. The distribution of *Problema* (Fig. 12) suggests at least two periods of isolation in Florida, one of which gave rise to *P. bulenta* Boisduval and LeConte. The isolated Florida *Hesperia metea* also probably represent a prior refugium, perhaps cut off at a time when Florida was an island. Isolation during the Pleistocene may have contributed to the origin of *Lethe eurydice fumosa,* the range of which consists today of widely disjunct colonies from Colorado to Iowa (Fig. 3).

The disjunct occurrence of *L. e. fumosa* in Colorado is duplicated in *Erynnis martialis* Scudder, a species otherwise very differently distributed (Fig. 15, modified from Burns, 1964). *E. martialis* also occurs disjunctly in the Black Hills of South Dakota, also probably as a relict of its pre-xerothermic distribution. The northern limits in the plains today are in the bottomlands of the Missouri and Mississippi Rivers. *E. martialis* seems to have taken both the eastern and western routes northward. Its populations in central New York (Tompkins, Schuyler, Cayuga, Yates Counties) may be disjunct from those in the Hudson Valley and Albany County; if so it and *Pyrgus communis* (discussed below) would be the only non-marsh skippers to show this pattern. There is no phenotypic differentiation evident among the various populations of *E. martialis,* but contrary to the statements of Burns (1964), it is univoltine at least in central New York.

TWO MULTIPLE-RELICT AREAS

The Omaha, Nebraska area seems to have been a xerothermic refugium for at least six butterfly species, two of which (*Boloria selene nebraskensis* Holland and *Euphyes conspicua bucholzi*)

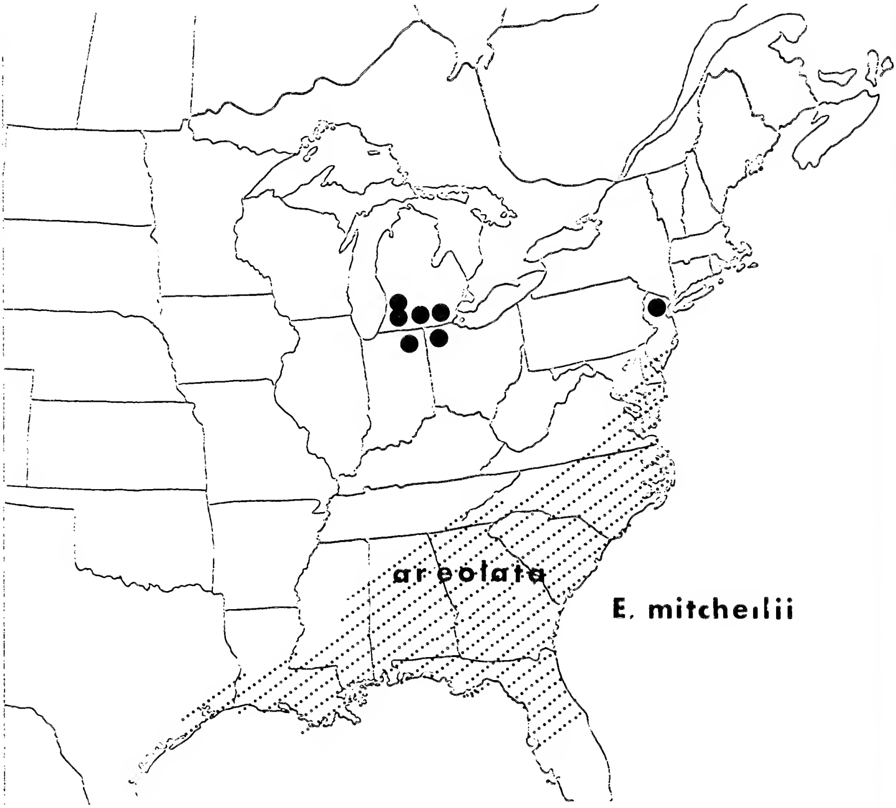


Fig. 9.—Distribution of *Euptychia areolata* and *E. mitchellii*.

developed distinctive endemic forms there. Nebraska *Poanes v. viator* are larger and brighter than other populations of that subspecies, but no information is at hand on their biology. The other three relict species are *Euphyes bimacula, Poanes massasoit* and *Lethe eurydice fumosa.*

The Omaha area was well suited as a refugium because of its ravines and valleys, deepened in Wisconsin time and later partly filled with alluvium on which marshes developed (Reed *et al.*, 1965). If this explanation of the relicts is correct, they must have reached Nebraska from the north and east (except perhaps *L. e. fumosa*?) before the xerothermic maximum. *Erynnis horatius* and *E. martialis* reach their northernmost plains stations near Omaha today (Burns, 1964) in bottomland forest; these do not appear to be relict occurrences.

Another noteworthy multiple-relict area for butterflies is the Great Dismal Swamp on the Coastal Plain at the North Carolina-Virginia border. Clark and Clark (1951) list from there the following "upland" species: *Lethe appalachia* Chermock, *Euphyes conspicua, Poanes hobomok* Harris, and *Speyeria diana* Cramer. Pollen data for the Swamp (Whitehead, 1965) do not help to explain this disjunct faunal component, although the full-glacial vegetation was more "northern" than today. The Clarks were of the opinion that intervening populations on the Piedmont, connecting those in the mountains and the Dismal Swamp, had been exterminated by man.

THE RANGE OF *PYRGUS COMMUNIS*

The distribution and biology of the common Checkered Skipper are especially instructive in underlining the problems of inference from contemporary butterfly ranges. This is a vagile insect and an active colonizer of ruderal and old-field habitats, wherever its food plants (weedy Malvaceae, especially *Malva*) grow. Its populations probably correspond in structure to Wright's "neighborhood" model (Wright, 1951). It is one of the most widely distributed butterflies in North America, and is found throughout the east except in eastern New York and Pennsylvania and most of New England (Fig. 16). There is a marked disjunction through the same area as those of the marsh butterflies discussed earlier.

P. communis seems to have come northward behind the ice on both sides of the Appalachians, and its distribution is continuous across them south of Virginia. It is abundant in much of the Great Lakes region and extends east across southern

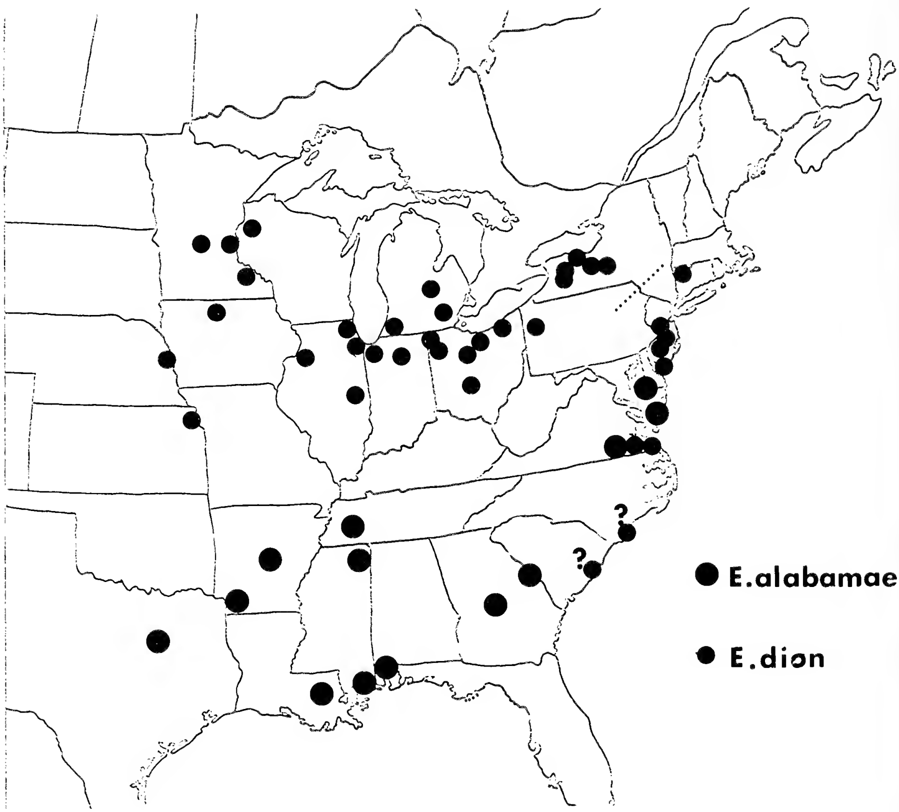


Fig. 10.—Distribution of *Euphyes dion* and *E. alabamae*. Note disjunction in eastern New York.

Ontario and the western half of New York. At least the New York range is recent, perhaps abetted by man. The first Ithaca specimens were taken about 1900; the first Erie County record is 1910 (Forbes, 1928). At Ithaca *P. communis* overwinters every year and has a large late spring flight. This seems to be duplicated throughout its upstate New York range, despite the severe winters. On the Coastal Plain the situation is very different; *P. communis* does not overwinter regularly anywhere north of Philadelphia, and even there stops at the Fall Line (Shapiro, 1966). The Connecticut and Massachusetts records are based on rare casuals, and the insect seldom overwinters at New York City (Davis, 1910; Forbes, 1928; Beutenmuller, 1902). At Philadelphia it seems clear that the distribution of *P. communis* is climatically limited. The western New York population does not appear to be spreading any further eastward; the same factors which limit the northward spread from the Coastal Plain may be limiting it as well. But it is also possible that the eastern and western insects are genetically differentiated with respect to overwintering ability, an hypothesis which could be tested by an introduction. There are no gross life history differences between the two stocks. The male genitalia of *P. communis* are very variable, showing more variation among individuals from the same date and locality than is found among species in many butterfly genera. No pattern of variation correlated with geography has been found.

Whatever the reason for its eastern New York disjunction, *P. communis* demonstrates that superficially similar distributions need not be related at all. There is nothing in its history or biology to suggest any community of interpretation with the marsh species.

The range of the introduced European Skipper, *Thymelicus lineola* Ochs., in North America as figured by Burns (1966) might suggest a climatic basis for disjunctions across central New York and Pennsylvania. In this case, however, it is known that somehow the insect "jumped" from the Lakes region to the Piedmont in Pennsylvania about 1952, and New Jersey about 1957. The gap between these expanding populations has been closed since 1967, and *lineola* now occupies all of central and western New York and also occurs in northeastern Pennsylvania (Shapiro, unpublished).

CONCLUSION

Historical biogeography is necessarily highly speculative.

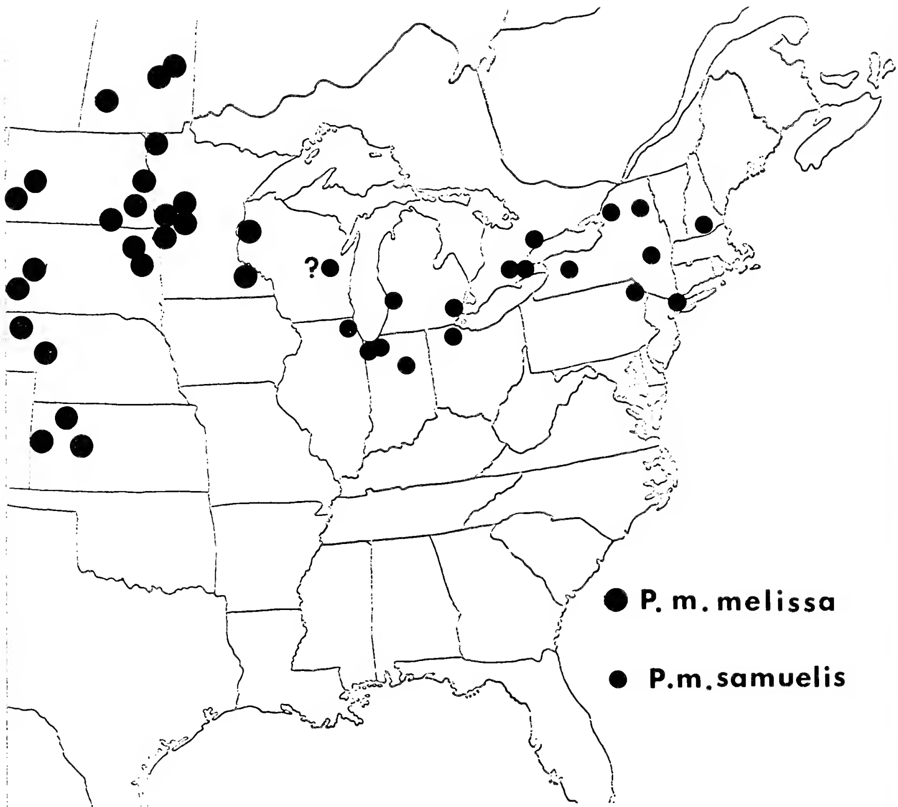


Fig. 11.—Distribution of *Plebeius melissa samuelis* and the eastern range of *P. m. melissa.*

This is even truer for butterflies, which in general leave no fossils, than for plants, which do. There is no butterfly equivalent of pollen profiles. Nonetheless, butterflies are so broadly dependent on plants that they would be expected to have followed them in their glacial and postglacial range changes. Interpretations of butterfly distributions must rely heavily on biogeographic evidence from other groups. They are also hampered by the difficulty in assembling large bodies of reliable data. Munroe (1969) has examined the ranges of some of the butterflies of Ontario. As he notes, both extensive surveys and intensive local studies are still revealing unexpected distributional information even in supposedly well-worked areas. Such new information may well require the re-evaluation of many of the ranges discussed in this paper.

Still, certain consistencies have appeared. There are about 450 species of butterflies recorded from North America east of the plains (Klots, 1951), of which about 130 each occur in New York (Forbes, 1928) and Pennsylvania (Shapiro, 1966; Tietz, 1952). Only seven species show a clear-cut Great Lakes-Coastal Plain range disjunction; all but one of these (which differs from the others in recent history as well as in biology) are marsh sedge feeders, and they make up a very large proportion of the eastern marsh butterflies. All of the remaining marsh sedge feeders (except salt marsh species, Florida endemics, and the subarctic Satyrids) show distributions related to the Great Lakes-Coastal Plain pattern. The common element in all these ranges seems to have been reliance on the post-Wisconsin Hudson-Mohawk outlet of Lake Ontario as a corridor connecting the Great Lakes and the Coastal Plain. The critical evidence needed to refute this hypothesis for a given species would be the existence of relict populations in the Mississippi Valley. For species with a break in New York and Pennsylvania, this would suggest that the Great Lakes populations were derived by migration from the southwest or south rather than the east, and that the gap in the range was analogous to that in *Pyrgus communis* —reflecting failure of two northward-moving populations to meet, rather than the extinction of previously connecting populations.

SUMMARY

1. Sedge-feeding marsh butterflies in eastern North America tend to be distributed in some variant of a basic Coastal Plain-Great Lakes pattern, often involving a break across

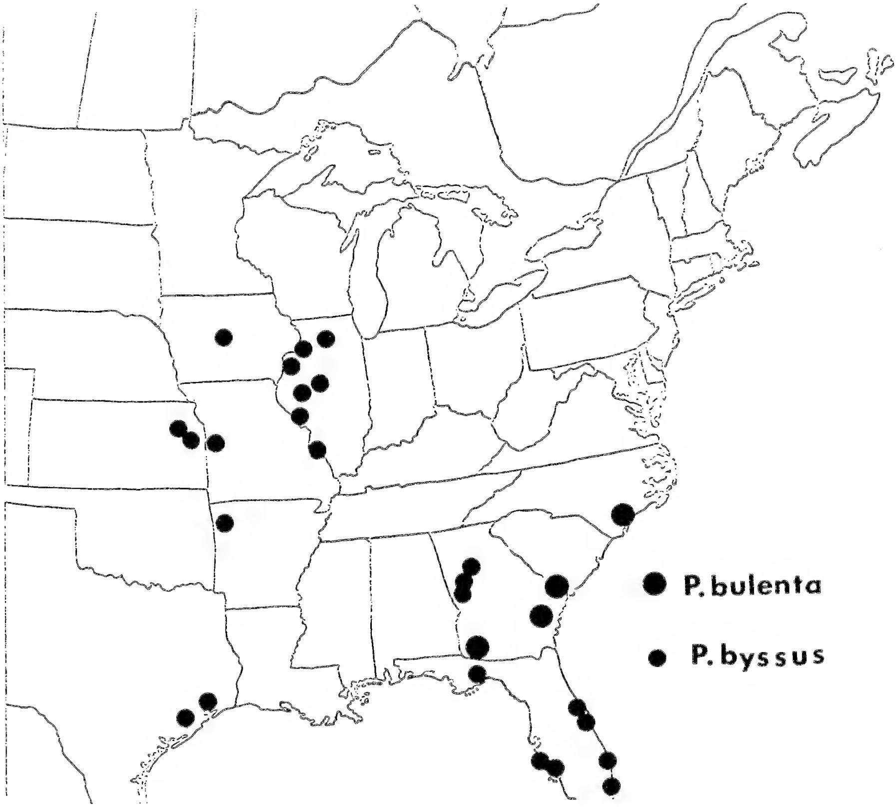


Fig. 12.—Distribution of *Problema byssus* and *P. bulenta*.

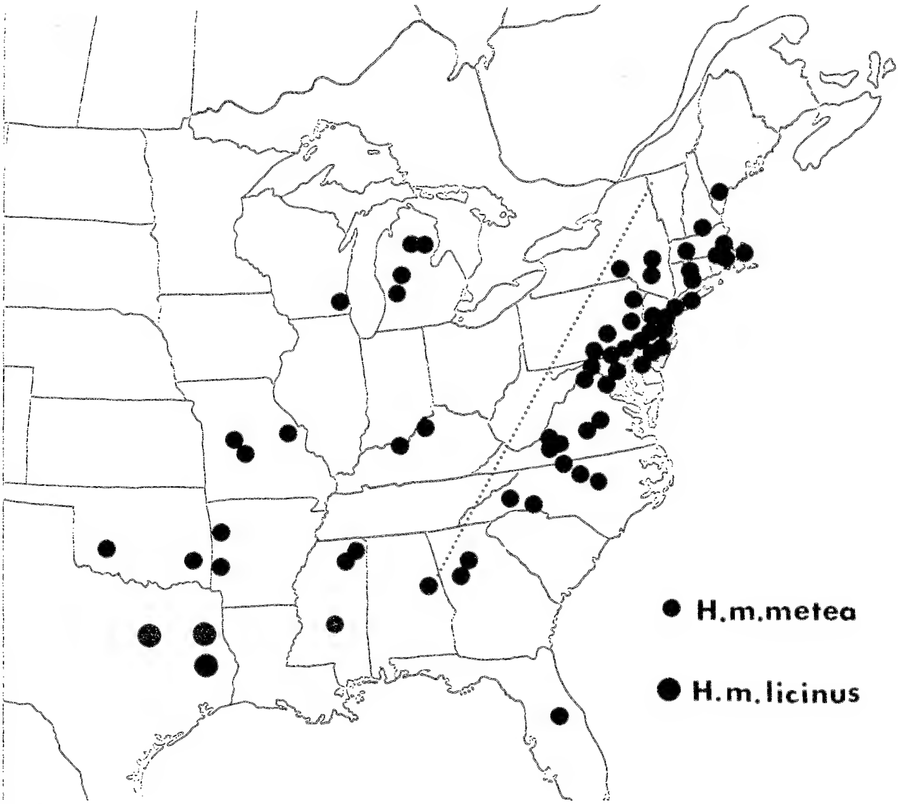


Fig. 13.—Distribution of *Hesperia metea.*

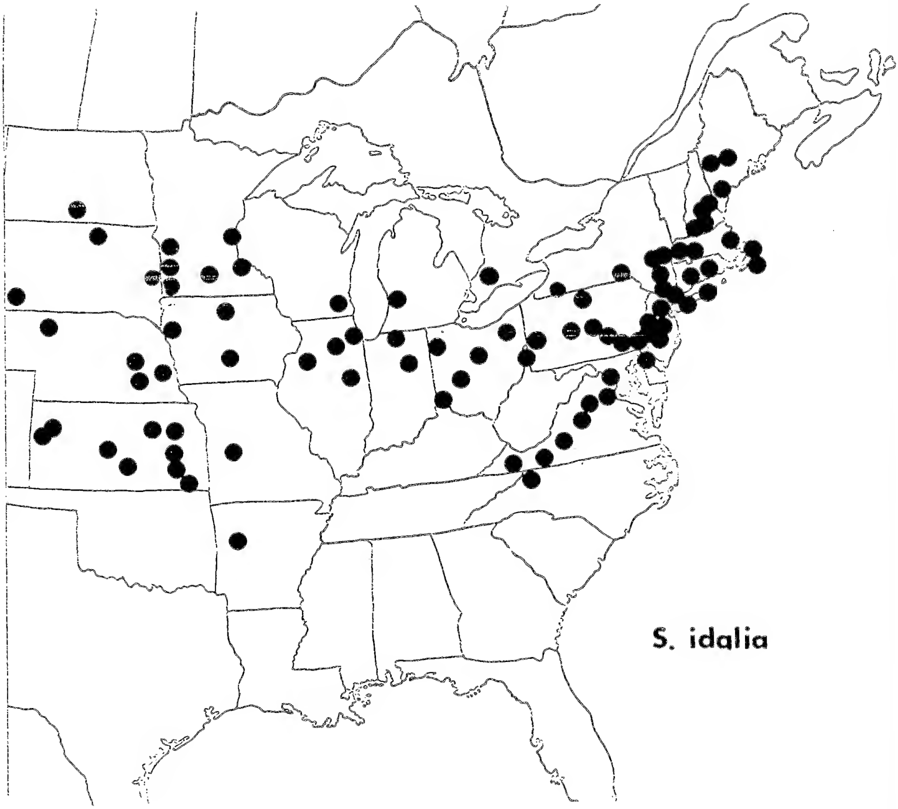


Fig. 14.—Distribution of *Speyeria idalia*.

New York and Pennsylvania. This type of distribution is rare in butterflies with different ecologies.

2. The prior existence of the Hudson-Mohawk outlet of Lake Ontario provides a hypothetical corridor for the migration of marsh species between the Coastal Plain and the Great Lakes. The isolated Beaver Creek population of *Poanes massasoit* confirms the prior existence of that species in an area of apparent range disjunction.
3. Evidence is presented which suggests that non-marsh, non-sedge feeding species with possible disjunctions in New York and Pennsylvania migrated northward after the Pleistocene both east and west of the Appalachians. These populations may have failed to meet in the northeast.

ACKNOWLEDGMENTS

Distributional data were kindly provided by all the persons and institutions acknowledged in Shapiro, 1970b. Special thanks are due to R. Irwin, Illinois Natural History Survey, for unpublished Illinois and Indiana records; R. T. Cardé, Cornell University, for suggestions and technical assistance; and Dr. L. L. Pechuman, Cornell University, for information on disjunct ranges in various other insects.

LITERATURE CITED

BAILEY, J. S. 1877. Center, N.Y. entomologically considered. *Canad. Ent.* 9:115-119.

BEUTENMULLER, W. 1902. The butterflies of the vicinity of New York City, Guide leaflet 7, suppl. to Amer. Mus. Journal, v. 2.

BLATCHLEY, W. S. 1920. Orthoptera of northeastern Ameica. Indianapolis. 784 pp.

BURNS, J. M. 1964. Evolution in skipper butterflies of the genus *Erynnis*. *U. Calif. Publ. Ent.* 37:214 pp.

________. 1966. Expanding distribution and evolutionary potential of *Thymelicus lineola*, an introduced skipper. *Can. Ent.* 98:859-866.

CARDÉ, R. T., A. M. SHAPIRO and H. K .CLENCH. 1970. Sibling species in the *eurydice* group of *Lethe* (Lepidoptera: Satyridae). *Psyche* 77 (1): 70-103.

CLARK, A. H. and L. F. CLARK. 1951. Butterflies of Virginia. *Smithson. Misc. Coll.* 116 (7):239 pp

CORNELL UNIVERSITY. 1926. The Lloyd-Cornell Reservation. Cincinnati: Lloyd Library. 247 pp.

COX, D. D. 1959. Some postglacial forests in central and eastern New York State as determined by the method of pollen analysis. *N.Y. State Mus. Sci. Serv., Bull.* 377: 52 pp.

COX, D. D. and D. M. LEWIS. 1965. Pollen studies in the Crusoe Lake area of prehistoric Indian occupation. *N.Y. State Mus. Sci. Serv., Bull.* 397: 29 pp.

CUSHING, E. J. 1965. Problems in the Quaternary phytogeography of the Great Lakes region. *in* H. E. Wright, Jr. and D. G. Frey, eds., The Quaternary of the United States. Princeton: Princeton University Press. pp. 403-416.

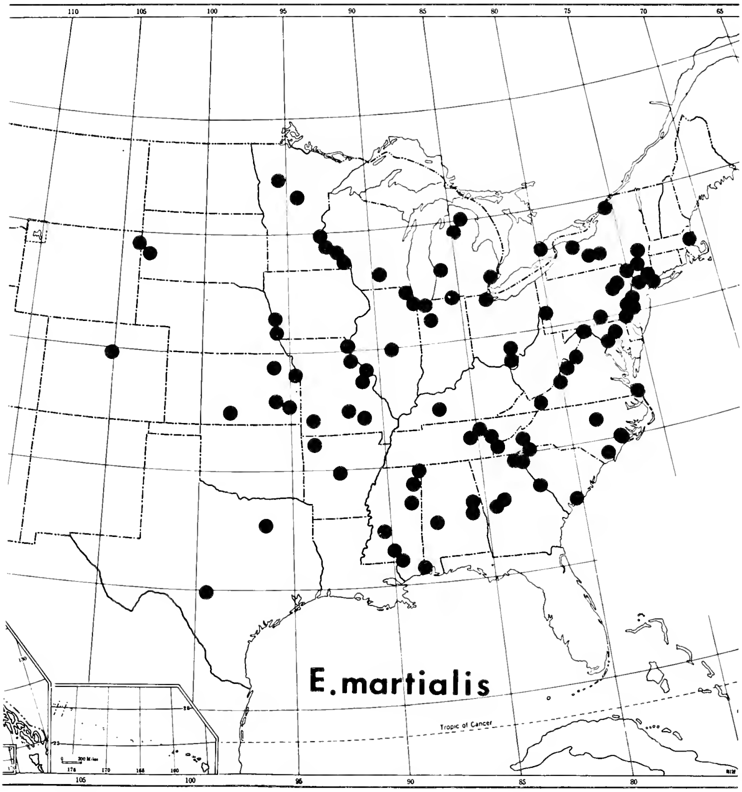


Fig. 15.—Distribution of *Erynnis martialis.*

DAVIS, M. B. 1963. On the theory of pollen analysis. *Amer. J. Sci.* 261: 897-912.

________. 1965. Phytogeography and palynology of the northeastern United States. *in* H. E. Wright, Jr. and D. G. Frey, eds., The Quaternary of the United States. Princeton: Princeton University Press. pp. 377-402.

DAVIS, W. T. 1910. List of the Macrolepidoptera of Staten Island, New York. *Proc. Stat. I. Assn. Arts Sci.* 3:1-30.

DEEVEY, E. S., Jr. 1949. Biogeography of the Pleistocene. *Bull. Geol. Soc. Amer.* 60:1315-1416.

DILLON, L. S. 1956. Wisconsin climate and life zones in North America. *Science* 123:167-176.

EDWARDS, W. H. 1865. Description of certain species of diurnal Lepidoptera found within the limits of the United States and British America. IV. *Proc. Ent. Soc. Phila.* 4:201-204.

FLINT, R. F. 1947. Glacial Geology and the Pleistocene Epoch. New York: Wiley. 589 pp.

FORBES, W. T. M. 1928. Lepidoptera. *in* W. D. Leonard, ed., A list of the insects of New York. *Cornell Univ. Agr. Expt. Sta., Mem.* 101, pp. 532-687.

FRENCH, G. H. 1885. The butterflies of the eastern United States. Philadelphia: J. B. Lippincott. 414 pp.

GLEASON, H. A. 1922. The vegetational history of the Middle West. *Ann. Assn. Amer. Geog.* 12:39-85.

HITCHCOCK, A. S. and P. C. STANDLEY. 1919. Flora of the District of Columbia and vicinity. Contrib. U. S. Nat. Herbar. 21:329 pp.

HOUGH, J. L. 1958. Geology of the Great Lakes. Urbana: University of Illinois Press. 313 pp.

KING, P. B. 1965. Tectonics of quaternary time in middle North America. *in* H. E. Wright, Jr. and D. G. Frey, eds., The Quaternary of the United States. Princeton: Princeton University Press. pp. 831-870.

KLOTS, A. B. 1951. A field guide to the butterflies. Boston: Houghton Mifflin Co. 349 pp.

KNETZLER, A. 1912. Observations on the Lepidoptera of St. Louis, Mo. and vicinity during 1911. *Ent. News* 23:203-207.

McALPINE, W. S., S. P. HUBBELL, and T. E. PLISKE. 1960. The distribution habits and life history of *Euptychia mitchellii* (Satyridae). *J. Lepid. Soc.* 14:209-227.

McLAUGHLIN, W. T. 1932. Atlantic coastal plain plants in the sand barrens of northwestern Wisconsin. *Ecol. Monogr.* 2:335-384.

McNEILL, J. 1902. The Orthopteran genus *Trimerotropis*. *Psyche* 9:27-36.

MATHER, B. 1963. *Euphyes dukesi*: a review of knowledge of its distribution in time and space and its habitat. *J. Res. Lepid.* 2:161-169.

________. 1965. *Euptychia areolata*: distribution and variation, with special reference to Mississippi (Satyridae). *J. Lepid. Soc.* 19:139-160.

MATHER, B. and K. MATHER. 1958. The butterflies of Mississippi. *Tulane Stud. Zool.* 6:64-109.

MUNROE, E. 1969. Insects of Ontario: geographical distribution and postglacial origin. *Proc. Ent. Soc. Ontario* 99:43-50.

PEATTIE, D. C. 1922. The Atlantic Coastal Plain element in the flora of the Great Lakes. *Rhodora* 24:57-70, 80-88.

REED, E. C., V. H. DREESZEN, C. K. BAYNE, and C. B. SCHULTZ. 1965. The Pleistocene in Nebraska and northern Kansas. *in* H. E. Wright, Jr. and D. G. Frey, eds., The Quaternary of the United States. Princeton: Princeton University Press. pp. 187-202.

RUTKOWSKI, F. 1966. Rediscovery of *Euptychia mitchelli,* (Satyridae) in New Jersey. *J. Lepid. Soc.* 20:43-44.

SCUDDER, S. H. 1889. The butterflies of the eastern United States and Canada. Cambridge, Mass.: Author. 3 vols. 1956 pp.

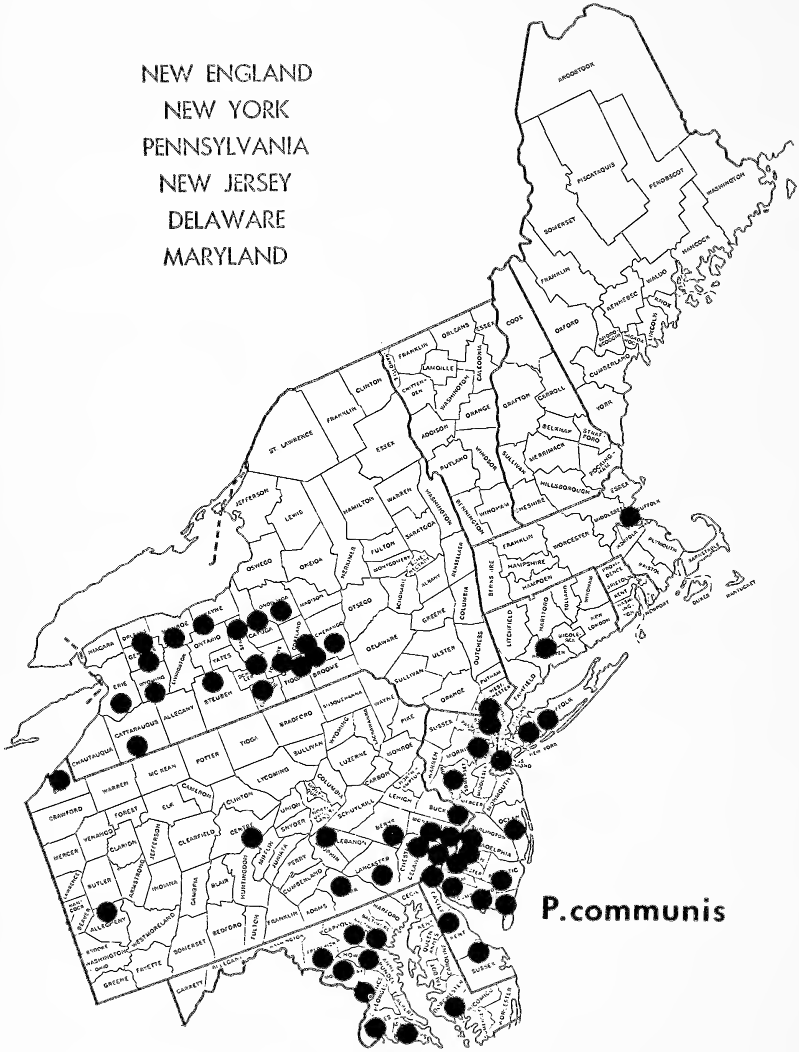


Fig. 16.—Northeastern U.S. distribution of *Pyrgus communis.*

SELL, R. A. 1916. Hunting butterflies in the Ozarks. *Ent. News* 27:55-56.

SHAPIRO, A. M. 1965. Ecological and behavioral notes on *Hesperia metea* and *Atrytonopsis hianna* (Hesperiidae). *J. Lepid Soc.* 19:215-221.

________. 1966. Butterflies of the Delaware Valley. Phila.: Amer. Ent. Soc. 79 pp.

________. 1969. New distributional data on three northeastern United States butterflies. *J. Lepid. Soc.* 23:265-269.

________. 1970a. Butterfly mysteries at McLean. *Cornell Plantations* 26: 3-6.

________. 1970b. Notes on the biology of *Poanes viator* (Hesperiidae) with the description of a new subspecies. *J. Res. Lepid.* In press.

SHAPIRO, A. M. and R. T. CARDÉ. 1970. Habitat selection and competition among sibling species of Satyrid butterflies. *Evolution* 24:48-54.

SMITH, P. W. 1957. An analysis of post-Wisconsin biogeography of the prairie peninsula region based on distributional phenomena among terrestrial vertebrate populations. *Ecology* 38:205-218.

TAYLOR, F. B. 1915 *in* F. Leverett and F. B. Taylor, eds., The Pleistocene of Indiana and Michigan and the history of the Great Lakes. *U.S. Geol. Surv. Monog.* 53: 529 pp.

TERASMAE, J. 1969. A discussion of deglaciation and the boreal forest history of the northern Great Lakes region. *Proc. Ent. Soc. Ontario* 99: 31-42.

TIETZ, H. M. 1952. The Lepidoptera of Pennsylvania: A Manual. University Park: Penn. State University. 194 pp.

WHITEHEAD, D. R. 1965. Palynology and Pleistocene phytogeography of unglaciated eastern North America. *in* H. E. Wright, Jr. and D. G. Frey, eds., The Quaternary of the United States. Princeton: Princeton University Press. pp. 417-432.

WRIGHT, S. 1951. The genetical structure of populations. *Ann. Eugenics* 15:323-354.

ZOLTAI, S. C. 1969. Glacial history of the upper Great Lakes. *Proc. Ent. Soc. Ontario* 99:15-20.

CORRECTION

OPLER, PAUL A. and J. S. BULETT. (1970) 1971. Seasonal distribution of "Macrolepidoptera" in Santa Clara County, California. J. Res. Lepid. 9(2):75-88.

On page 85 of above paper, data for fig. 8 (page 86) was inadvertantly used for fig. 6. The correct data for fig. 6 is that following:

	New Almaden	Walnut Creek	Santa Monicas	Modoc County	Corvallis, Oregon
New Almaden	———				
Walnut Creek	137 46%	———			
Santa Monicas	129 37%	135 38%	———		
Modoc County	68 16%	60 13%	62 13%	———	
Corvallis, Oregon	108 24%	105 22%	99 19%	83 15%	———

Journal of Research on the Lepidoptera 9(3): 157-167, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

THE EFFECT OF CAUTERIZING THE PPM ("GOLD SPOTS" OF AUTHORS) OF THE PUPA OF THE MONARCH BUTTERFLY (*D. plexippus*)

F. A. URQUHART and A. P. S. TANG

Department of Zoology and Scarborough College, University of Toronto, Canada

INTRODUCTION

It is the purpose of this paper to describe the effect of microcauterizing the Prismatic Pigmented Maculae (PPM), commonly referred to as "gold spots," of the monarch butterfly (Fig. 1). We have chosen the terminology "prismatic pigmented maculae" in place of "gold spots" for the following reasons:

The word "gold," as a descriptive term, is meaningless, nor would the use of the word "golden" be much of an improvement. The choice of the word came about because of the yellow metallic luster associated with these particular areas (Fig. 1). In other species of Lepidoptera, however, such pigmented areas may be green, light blue, or a combination of colors to which the word gold would then not apply. Since metallic luster is a prismatic effect and since the areas are pigmented, we suggest the terms "prismatic pigmented" as being more descriptive and in keeping with the results of histological studies that have been published, as well as those carried out in our laboratory (unpublished).

The word "spot" is an ambiguous term. For example: "cold spot" refers to any one of the temperature spots where cold is normally perceived and thus refers to an area of sensitivity; it may refer to an area instantaneously affected by the impact of an electron beam in a cathode ray tube, thus referring to a light spot; and so on. In an attempt to avoid such ambiguity we suggest the use of the word "macula(ae)." This term is used extensively in biology, and more particularly in certain branches of medicine, as a "general term to designate an area distinguishable by color or otherwise from the surrounding area" — for

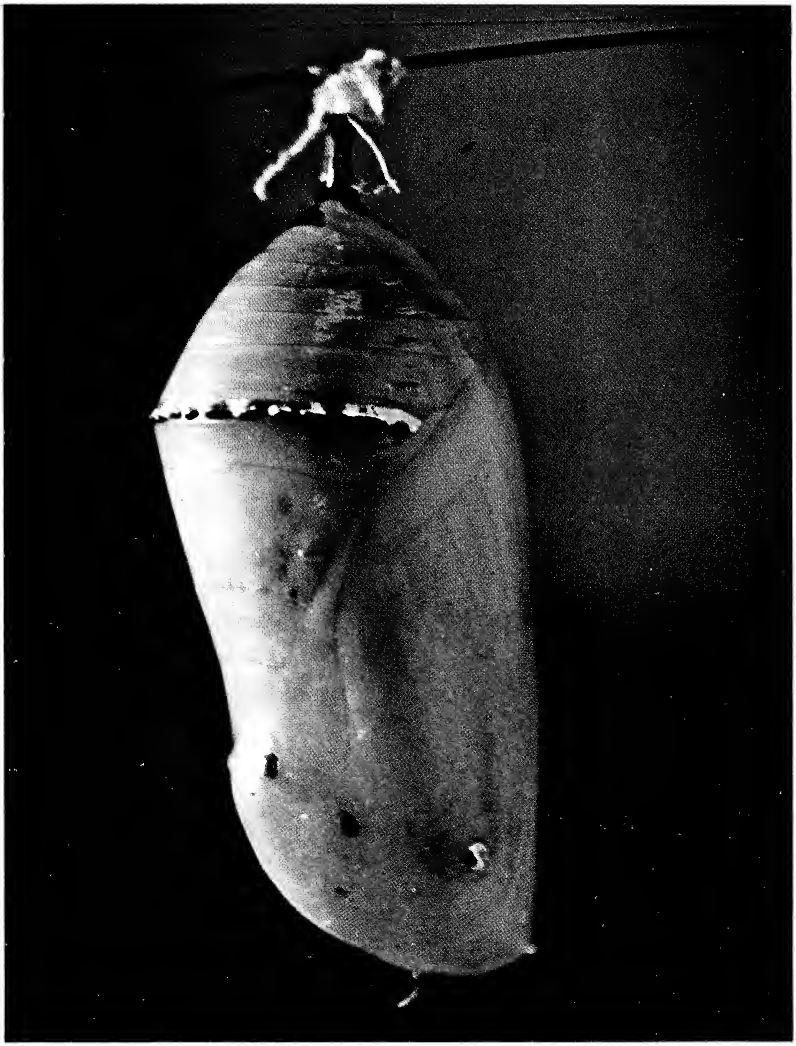


Fig. 1. Pupa of the monarch butterfly showing the prismatic pigmented maculae on one side.

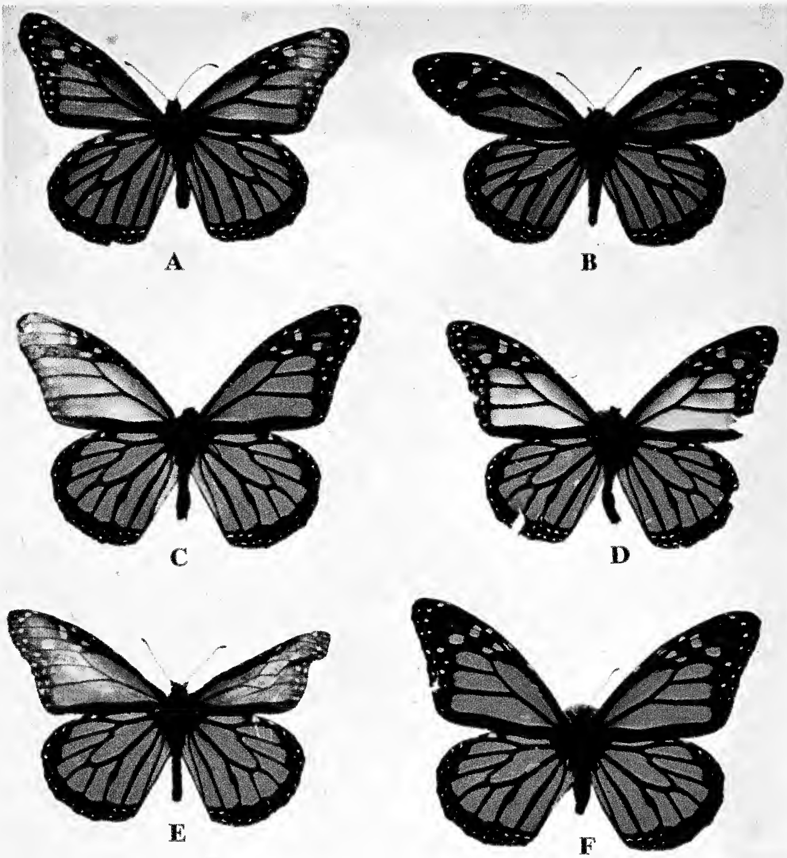


Fig. 2. Results of cauterization of the pupal LUPPMs and LNPPMs. A: Both LUs cauterized showing fading in both wing tips. B: Forewings distorted but no fading when area remote from PPMs is cauterized. C: Left LU and LN cauterized on left side only and showing extended area of fading on left forewing. D: Both LNs cauterized showing fading in central area of forewing and absence of apical fading. E: Cauterizing of LUs for 20 secs. showing extreme fading in left forewing and fading and distortion in right forewing. F: LUs cauterized for 3 secs. with no resultant fading (this specimen is taken as normal coloration for comparison with the other treated specimens in this plate).

example: "maculae caeruleae" referring to a purple area; or "maculae luteae" referring to a yellow area; and so on. We decided on such terminology because we are of the opinion that further research will indicate much more important functions for these structures than presented in this paper and a uniformity of terminology will permit a much clearer definition of the results obtained for discussion among those carrying out research in this area.

Thus, the structures found on the pupa of the monarch butterfly, considered in the present discourse, are referred to as *prismatic pigmented maculae,* which may be conveniently shortened to PPM. It is noted that some of the areas may not be prismatic, as in the case of the *ventral frontal* and *dorsal frontal* PPMs of the monarch butterfly pupae and which are also found in other species of Lepidoptera; these may be referred to as being *pigmented maculae.* If both the prismatic effect and color are absent then such areas may be designated as *"unpigmented maculae."* This permits a wider use of the terms while at the same time confining the description and the research in this field to a more logical presentation.

In order that such pupal structures may be discussed, Urquhart (1960) suggested terms for the various PPMs located on the pupa of the monarch butterfly (Fig. 3). The terms, for the most part, refer to the structures of the developing imago upon which the maculae are located. Thus "ocular" refers to the PPMs associated with the compound eyes; "lateral ulnar" to those located at the bases of the first pair of wings as distinct from those located on the wing ("alar"). The choice of the term "ulnar," which is perhaps not an applicable one, is used in the connotation of the ulnar joint of a vertebrate limb. "Lateral notal" refers to those located near the outside margin of the mesonotum; and so on. For convenience in textural reference these terms are shortened to "LU" for lateral ulnar; "LN" for lateral notal; and so on.

Urquhart (1960) suggested that the PPMs possibly acted as light receptors delaying emergence during periods of inclement weather. Petersen (1964) covered the spots with "fingernail polish" and concluded that either the polish was not effective in keeping out light rays or the PPMs do not function as photoreceptors during the emergence period. Although Petersen's experiment is by no means conclusive, it agrees with our studies (unpublished) in which the spots were covered with an opaque black enamel.

Taylor (1964) cut out the PPMs in some specimens and painted others with a black substance (material not stated). He found that all adults emerged from the pupae at the expected time and that the adults were normal.

PROCEDURE

The method of microcauterization described by Urquhart and Dampney (1964), in which a spark (fulguration) of a definite voltage was employed to destroy the tissues of the maculae, was used. The fulgurating point of the wire conductor was brought to within approximately 5 mm. of the macula to be treated. The time of fulguration was noted by use of a stop clock. Voltage was kept constant throughout all tests (2000 v.). The time of exposure varied: Some specimens were treated for one second in our initial trials; others for five seconds; ten seconds; and twenty seconds. This series of tests was carried out in order to ascertain the degree of damage to the cells of the maculae and the surrounding tissue.

As a control, specimens were cauterized in areas remote from the maculae.

In all, a total of 200 pupae were treated and of these 174 imagoes emerged. Lethality (26 specimens) was probably due to a viral infection and not the result of the cauterization (Urquhart, 1966).

Specimens were treated approximately one day after pupa ecdysis, a time period which, from our unpublished investigations, indicated that the cellular structure of the maculae was still unique and that the pigment was still present in the cells. It was, however, not possible to ascertain the exact hourly age of the pupa since eclosion at times took place early in the morning, or in the late evening, when the technician was absent from the laboratory. However, all pupae treated were in the range of 16 - 28 hours.

Thus, parameters such as pupal age, fulguration force (voltage), and time of exposure were kept as nearly constant as possible. However, the distance between the fulgurating point and the PPM was estimated under the dissecting microscope with the result that an error in judgment could have been made thus causing a difference in the degree of tissue destruction.

RESULTS

Specimens which were exposed for periods of 1 - 3 seconds indicated no wing fading (Fig. 2 F - this specimen is taken as normal pigmentation for comparison with the other specimens).

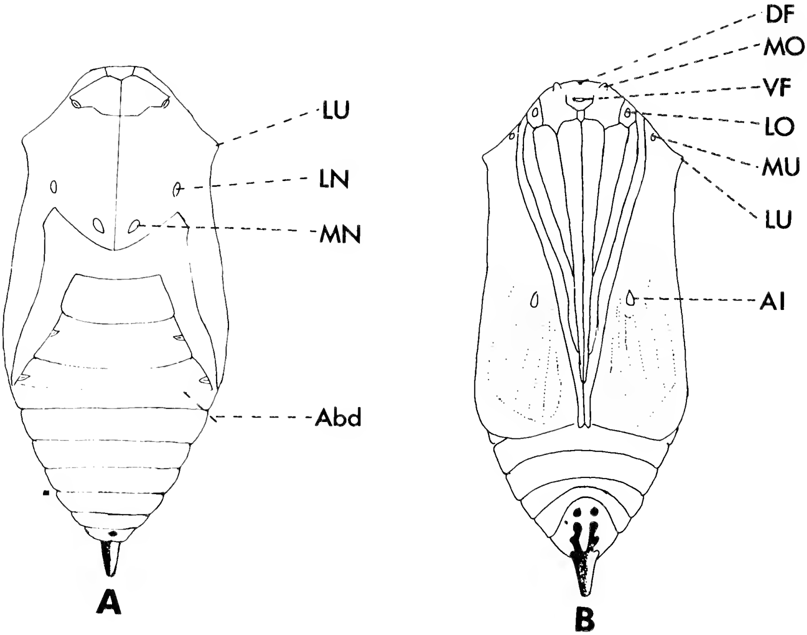


Fig. 3. Dorsal (A) and ventral (B) aspect of the pupa showing positions of the PPMs (LU: lateral ulnar; LN: lateral notal; MN: median notal; Abd: abdominal; DF: dorsal frontal; MO: median ocular; VF: ventral frontal; LO: lateral ocular; MU: median ulnar; Al: alar). VF and DF are non-prismatic and ephemeral — not discernible after 48 hrs.

Specimens exposed for a period of 5 - 8 seconds indicated fading in only a few of the specimens (20%). At ten seconds the majority of specimens indicated fading. At twenty seconds, although fading was evident in all specimens, the wings were, in many cases, distorted (Fig. 2 E). In all cases, fading of the scales occurred on both ventral and dorsal surfaces of the wing.

Of a total of 88 specimens in which both LUs were cauterized, 64 exhibited wing-tip fading (Fig. 2 A).

In some cases, when cauterization was extended beyond 10 seconds, or where the fulgurating point was too close to the PPM, fading tended to extend beyond the apical region (Fig. 2 E).

In order to test whether or not each of the pair of PPMs operated independently for each wing with which it was associated, only one of a pair of PPMs was treated and it was found that when the left PPM was cauterized only the left wing-tip faded and when the right one was cauterized only the right wing-tip indicated fading.

Of the controls (25 specimens) in which an area remote from the PPMs was cauterized for the same voltage and time, no fading was evident but the forewings were distorted (Fig. 2 B). The point of cauterization is seen at the branch of vein CU - M.

Of the remaining PPMs found on the body of the pupa the LNs and MOs were cauterized.

Of the 25 specimens in which the LNs were cauterized 18 indicated fading in the central portion of the wing and not at the wing-apex (Fig. 2 D).

When both LU and LN were cauterized on one side only the forewing of that side indicated fading for almost the complete wing area (Fig. 2 C).

When the area of the wing that had become faded was examined under the microscope it was found that the scales were, in some cases, normal in number per scale row but lacking pigment; others lacked pigment and there was also a reduction in the number per scale row; while still others were smaller in size and decidedly more elongate. In any one faded area one or more of these scale changes was found.

When the MOs were cauterized (25 specimens) all indicated a marked reduction in the number, or complete absence, of scales in the region of the fronto-clypeus and a distortion of the compound eyes due to the destruction of tissue beyond the area of the PPM (Fig. 4). In the latter case, the eyes tended to

Fig. 4. Micro-cauterization of the MOPPMs causes a marked reduction in the number of scales on the head (A) as compared to the normal head (B).

B

Fig. 4. Micro-cauterization of the MOPPMs causes a marked reduction in the number of scales on the head (A) as compared to the normal head (B).

be elongated, smaller in size, and divided into two parts by a transverse sulcus. In some instances (45%) the compound eyes were lighter in color — assuming a more coppery tone with irregular streaks of dark brown, in contrast to the more uniform pigmentation of the normal eye.

CONCLUSIONS

From an analysis of the data obtained from these introductory experiments, it would appear that the PPMs of the pupa exercise control over the formation, form and pigmentation of the scales. Further, each pair of PPMs seem to govern a certain area of the body with respect to the scales and not to other external structures — as demonstrated by the control experiment in which wing distortion took place but with no effect upon the scales.

It would appear that the LUPPMs govern scales on the apical portions of the forewings; the LNPPMs govern the scales located on the central plane of the forewings; and the MOPPMs govern the scales on the area of the fronto-clypeus.

As was previously pointed out, treatment by fulguration does not always produce the same results. We believe that this variation is due to the distance between the fulgurating point and the maculae not being constant; thus, the closer the fulgurating point is to the macula the greater the degree of PPM tissue destruction. There is also the difference in age of the pupa together with the difference of one or two seconds when taking time from a stop clock. The addition of all such variable parameters might be responsible for the variation in the effect of cauterization.

Although our experiments are by no means complete, since we are now investigating the other PPMs as well as designing an apparatus that will eliminate the variables mentioned above, we present this paper more in the nature of an "introductory report" with the hope that some of our colleagues interested in the physiology of the Lepidoptera may wish to carry out similar experiments with other species that possess PPMs in the pupal stage, as in the case of many species of Nymphalidae.

Reprints of our previous publication dealing with the method of microcauterization by fulguration will be sent to those of our colleagues interested in work of this nature.

ACKNOWLEDGMENT

This investigation, which is a small part of a much larger study dealing with the ecology and physiology of *Danaus*

plexippus was made possible by grants to the University of Toronto from the National Geographic Society and the National Research Council of Canada.

We wish to express our appreciation to David Harford, photographic technician of Scarborough College, for the excellent photographs accompanying this article.

LITERATURE CITED

PETERSEN, B. 1964. Humidity, darkness and gold spots as possible factors in pupal duration of monarch butterflies. *Jour. Lepid. Soc.* 18 (4): 230 - 232.

TAYLOR, R. L. 1964. The metallic gold spots on the pupa of the monarch butterfly. *Ent. News.* 75 (10): 253 - 256.

URQUHART, F. A. 1960. The monarch butterfly. University of Toronto Press: 361 pp.

URQUHART, F. A. 1966. Virus-caused epizootic as a factor in population fluctuations of the monarch butterfly. *Jour. Invert. Path.* 8: 492 - 495.

URQUHART, F. A. and DAMPNEY, P., 1969. Microcauterization to maxillectomize lepidopterous larvae by fulguration. *Can. Jour. Zoo.* 47 (6): 1416 - 1417.

AUTHOR'S NOTE:

Since submitting this paper for publication, we have found that the degree of cauterization must be changed for the various PPMs depending upon the depth of cuticle—thus, a higher degree of cauterization is necessary for the LU as compared to the Al (alar).

By utilizing the scale on the micromanipulator, it is possible to obtain a constant distance between the PPM and fulgurating point.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

HABITAT—*ARGYNNIS ADIASTE*

(See figures on page 192)

This species of *Argynnis,* like most around the world, is restricted to *Viola* for the larval food plant. The distribution of the species is restricted to the coastal section of central California from the Santa Cruz mountains, south of the San Francisco Bay, to the Tehachapi mountains just south of the Great Valley of California. A fuller discussion of the distribution and geographical variation in color will come soon in a subsequent issue.

The habitat of *A. adiaste* is usually openings in oak woodland, though the scaricity of populations throughout its range would indicate that rather special conditions are required for survival. Such an opening in the woods is shown in the upper figure on page 192. (Nacimiento Summit, Monterey County, California, June 1971). The ground between the trees is covered with oak leaves as shown on the lower figure on page 192, together with scattered groups of *Viola* sp. The particular *Viola* shown is not known definitely to be the food plant for the larvae, but the adults have been observed to react to them as if they were. Adults have been collected here three different years since 1960.

This same type of habitat appears in all other localities where *A. adiaste* or its races *atossa* and *clemencei* have been found.

Two other species of *Argynnis* occupy the same region with *adiaste,* namely, *callippe-macaria* and *snyderi.* Each of these occupies a somewhat different habitat which is difficult to define. The adults may fly together occasionally, but ususally not, *callippe* occupying warmer, open ridges and *snyderi* other areas, ill-defined but different from either. These three *Argynnis* are ecologically isolated by some, as yet unknown, factor which may be a specific difference of *Viola* for the larval food plant. This point should not be difficult to determine.

W. Hovanitz

Journal of Research on the Lepidoptera 9(3): 169-174, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

ADDITIONAL NOTES ON THE DISTRIBUTION AND FOODPLANT PREFERENCES OF *MEGATHYMUS COLORADENSIS NAVAJO* SKINNER (MEGATHYMIDAE)

RONALD S., JOSEPH R.[1] and DALE WIELGUS

3434 West Augusta, Phoenix, Arizona 85021

FOR THE PAST SEVERAL YEARS we have been engaged in the collecting of *Megathymus* larvae and pupae from *Yucca* colonies in central Arizona, subsequently securing a long series of adults from all localities. When we attempted to determine these using the key in the review of the family by Freeman (1969) some difficulty was encountered. The specimens were keyed tentatively to *Megathymus coloradensis navajo* Skinner only after considerable effort. However, a comparison of the specimens with the figures of *navajo* given in the plate in *Colorado Butterflies* (Brown, Eff and Rotger, 1957) revealed distinct differences, especially in the females. We hesitantly proceeded in the direction of a possible description of the central Arizona population pending receipt of more conclusive evidence.

A review of the literature treating the distribution and foodplant records of *navajo* was made. Aside from the rather scanty data available in Freeman (1969) and Brown, Eff and Rotger (1957) we could find little to support the possibility of the central Arizona population as being consubspecific with *navajo*. Indeed, the fact that the type locality for *navajo* is Fort Wingate, McKinley County, New Mexico (Skinner, 1911) only seemed to increase the possibility of the central Arizona population as being a distinct subspecies. This possibility was dispelled, however, when a comparison was made between examples of the central Arizona population and male specimens of *navajo* on loan from the American Museum of Natural History.

[1]4315 West Las Palmaritas, Glendale, Arizona.

Male and female phenotypes characteristic of the central Arizona population of *navajo*. Top row: Female ½ - 1½ miles north of Camp Creek, Maricopa County, Arizona, 18 II 1971; left, upperside; right, underside. Bottom row: Male, ½ - 1½ males north of Camp Creek, Maricopa County, Arizona, 22 II 1971; left, upperside; right, underside.

In the short series of *navajo* received was a male specimen collected in Globe, Arizona, May 24, 1933 (collector unknown) determined by H. A. Freeman. In locality cited and morphological characteristics this specimen corresponded well with our series of males from that area. It is on the basis of this one specimen that we unhesitatingly assign the central Arizona population of *Megathymus* to *navajo*. Our collecting records of *navajo* from central Arizona total a series of 243 specimens (130 males and 113 females) all ex larvae and pupae emerging in confinement from March 1968 to March 1971, collected from the following localities:

52 males and 48 females, reared from *Yucca baccata* Torrey found ½ - 1½ miles north of Camp Creek, Maricopa County, Arizona, 3500-3600 feet elevation, emerging from March 1968 to March 1971, R., D. & J. Wielgus, collectors.

6 males and 1 female, reared from *Y. baccata* found 4.3 miles southwest of intersection of Kellner and Icehouse Canyon Roads, Pinal Peak, Gila County, Arizona, 4600-4800 feet elevation, emerging from February 1970 to February 1971, R. & J. Wielgus, collectors.

2 males reared from *Y. baccata* and *Yucca elata* Engelmann found east of Russell Gulch, 2 miles south of Miami, Gila County, Arizona, emerging February 1971, R. & J. Wielgus, collectors.

29 males and 22 females reared from *Y. baccata* found ¼ - 1½ miles east of State Highway 87 on Hughes Corral Road, Maricopa County, Arizona, 2500 feet elevation, emerging from February 1969 to March 1971, R., D. & J. Wielgus, collectors.

31 males and 28 females reared from *Y. baccata* and *Yucca elata* var. *verdiensis* McKelvey found ½ - 2 miles east of State Highway 87 on State Highway 188, Gila County, Arizona, 3000-3200 feet elevation, emerging from February 1970 to March 1971, R., D. & J. Wielgus, collectors.

9 males and 8 females reared from *Yucca baccata* var. *vespertina* McKelvey found on the Storm Ranch, Granite Dells, Yavapai County, Arizona, 5000-5200 feet elevation, emerging from February 1971 to March 1971, R., D. & J. Wielgus, collectors.

1 male and 6 females reared from *Y. baccata* var. *vespertina* found at the north end of Willow Creek Reservoir, Section 11, T14N, R2W, Yavapai County, Arizona, R., D. & J. Wielgus, Collectors.

Foodplants: *Yucca baccata* Torrey, *Yucca Baccata* var. *vespertina* McKelvey, *Yucca elata* Engelman and *Yucca elata* var. *verdiensis* McKelvey.

The 243 specimens of *navajo* collected by the authors will be distributed as follows: 29 males and 22 females to the Allyn Museum of Entomology; 17 males and 17 females to the American Museum of Natural History; 6 males and 7 females to Arizona State University; 2 males and 2 females to the California Academy of Sciences; 33 males and 30 females to the Los Angeles County Museum of Natural History; 12 males and 10 females to Lloyd M. Martin; 10 males and 7 females to the United States National Museum; 12 males and 10 females to Don B. Stallings and 9 males and 8 females to the collection of the senior author.

In view of the difficulty encountered in determining the correct subspecies nomen to assign to the central Arizona popu-

lation through the use of the original description (Skinner, 1911), redescription (Freeman, 1943) and key (Freeman, 1969), we feel that it is necessary that the previous descriptions be expanded to include the following redescription applicable to atypical *navajo* as is found in central Arizona. This redescription is based on the previously mentioned 243 specimens collected by the authors.

Female. Upper surface of primaries: deep black with few yellow-brown hairs near base; slight line of white overscaling from apex along outer margin usually not extending caudad of vein Cu_1; spot 1 (cell spot) squarish; spots 2, 3 and 4 nearly twice as wide as high and equal in size; spot 3 extending slightly inwardly in some specimens; spots 5 and 6 narrow, one-half as wide as high; spot 7 square, slightly shorter than spot 8, toothed inwardly, extending one-half or less distance to cell spot, may or may not reach inner edge of spot 6; spot 8 square, toothed inwardly; spot 9 larger than spot 8, sharply toothed inwardly and notched outwardly; spots 7 and 8 with outer edge in straight line angled inwardly; spots 1, 7, 8 and 9 yellow; spots 5 and 6 very light yellow, spot 5 almost white in some specimens; spots 2, 3 and 4 white; fringes checkered smoke-gray and black.

Under surface of primaries: black, outer margin overscaled with white, all spots of upper surface reappearing; spots 2, 3 and 4 equal in size, white; spot 5 narrow, concave outwardly, white; spot 6 narrow, one-third as wide as high, very light yellow; spots 7, 8 and 9 same size and shape as on upper surface, light yellow; white portion of checkered fringe with light overscaling of black scales.

Upper surface of secondaries: black with very few yellow-brown hairs near base; light yellow spots of discal band, a phantom spot only rarely with two small spots below (spots 10 and 11), followed by two well defined squarish spots (spots 12 and 13) and very faint phantom spot only rarely (spot 14); spot 10 obsolete or reduced to minute dot in some specimens; spot 11 half as large as spot 12, usually smaller in some specimens and inward of spots 12 and 13; fringes white with vein tips black.

Under surface of secondaries: black with costal margin and outer margin overscaled with white giving gray appearance in those areas; two narrow triangular white spots in costal area, outer one obsolete in some specimens; discal band indicated by lighter overscaling.

Abdomen: black above, dark brownish gray to black below. Thorax: gray with some brownish hairs above, darker below.

Palpus: white with few scales black tipped. Antenna: club above and below black, shaft ringed with white and black.

Length of forewing 27 mm to 34 mm, average 31.1 mm.

Male. Upper surface of primaries: black, similar to female with spots smaller and lighter in color; spot 4 usually one-half width of spot 2; spot 5 usually deeply concave outwardly, reduced to two lines of color along veins in some specimens; spot 6 narrow, one-half as wide as high; spots 7, 8 and 9 toothed inwardly; spots 7 and 8 with outer edge in straight line angled inwardly, spot 7 may or may not reach inner edge of spot 6; in some specimens spots 7 and 8 narrow, one-half as wide as high.

Under surface of primaries: similar to female with spots smaller; spots 2, 3, 4, 5 and 6 white; spots 1, 7, 8 and 9 light yellow.

Upper surface of secondaries: black with broad creamy yellow margin; black scaling along veins Cu_1, Cu_2 and 2A, contrasting with margin.

Under surface of secondaries: black with costal margin and outer margin overscaled with white giving gray appearance in those areas; two white spots in costal area, inner one moderately large, triangular, outer one reduced to mere dot or obsolete in some specimens; discal band only faintly indicated by lighter overscaling most conspicuous in cell Cu_2.

Abdomen, thorax, palpus and antenna same as in female.

Length of forewing 23 mm to 28 mm, average 25.5 mm.

DISCUSSION

This subspecies is distributed generally throughout central Arizona in an area roughly 50 miles wide by 200 miles long extending from southeast to northwest. In this area *navajo* is found in a variety of habitats and elevations, from the lower open desert country as is found along the Hughes Corral Road and at State Highway 188, through dense chaparral as is found on the lower slopes of Pinal Peak, and in spectacular rocky Pine-Juniper woodland as at the Storm Ranch locality. We have also found old larval tents and pupal skins in *Y. baccata* growing on the plateau above the town of Black Canyon, north of Sunset Point, Yavapai County. This area is relatively flat and the *Yucca* colony enormous, extending for miles to the northeast. In addition, we have one male collected in flight in Rackensack Wash near Camp Creek, Maricopa County, on 5 IV 1969, and one male collected in flight 2 miles south of Jerome, Yavapai County, on 4 IV 1970.

Throughout its range in central Arizona *navajo* is fairly constant in color and maculation. There is a distinct tendency among both sexes from all localities to exhibit a narrowing of the discal spot band on the upper surface of the primaries, and a reduction in size or obsolescence of spots 10 and 11 on the upper surface of the secondaries of the females. Size varied considerably within each sex but we did not attempt to correlate this with locality. The plate illustrates male and female phenotypes characteristic of the central Arizona population of *navajo.*

Of additional interest is the association of *navajo* with an undescribed subspecies of *Megathymus ursus* Poling, in which *Y. baccata* serves as the larval foodplant for each. In a later paper we will describe this *ursus* subspecies and attempt to clarify this association.

ACKNOWLDEGEMENTS

We would like to acknowledge the encouragement of Mr. Lloyd M. Martin and the many helpful comments and technical assistance he so generously gave. Special thanks are due to Dr. Frederick H. Rindge of the American Museum of Natural History for the loan of specimens of *navajo.* Thanks are also due to Mr. Don B. Stallings, Caldwell, Kansas, Mr. Thomas W. Davies, San Leandro, California and Dr. Lee D. Miller, Curator of Insects, Allyn Museum of Entomology, Sarasota, Florida, whose letters on the Megathymidae were greatly appreciated. We are also grateful to Mr. and Mrs. Storm for allowing us to remove infested *Yucca* plants from their ranch.

To our good friend, Dr. Frank F. Hasbrouck, Associate Professor of Zoology and Curator of Insects, Arizona State University, Tempe, Arizona, our sincerest gratitude for critically reviewing the manuscript and offering valuable suggestions.

LITERATURE CITED

BROWN, F. M., D. EFF & B. ROTGER, 1957. Colorado butterflies. Denver Museum of Natural History, Denver, Colorado, pp. 330-331.

DOS PASSOS, C. F., 1964. A synonymic list of the Nearctic Rhopalocera. *Lep. Soc. Mem.,* No. 1, v + 145 pp. New Haven, Conn.

FREEMAN, H. A., 1943. Notes on and redescriptions of *Megathymus yuccae* (Bdv. & LeC.) and its subspecies. *Ent. News,* 54: 213.

________, 1969. Systematic review of the Megathymidae. *J. Lep. Soc.,* 23, Supplement 1, 58 pp., 1 pl.

SKINNER, H., 1911. *Ent. News,* 22: 300.

Journal of Research on the Lepidoptera 9(3): 175-184, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

EIGHTEEN NEW OR SCARCE BUTTERFLIES FOR THE STATE OF MARYLAND

CONTRIBUTION NO. 4. NOTES ON MARYLAND LEPIDOPTERA

ROBERT S. SIMMONS and WILLIAM A. ANDERSEN
1305 Light St., Baltimore, Maryland 21230 U.S.A.

During progressive field studies on Maryland Butterflies (contributions Nos. 1-3 Notes on Maryland Lepidoptera: Simmons 1957, 1963 and Simmons and Andersen 1962) we are occasionally rewarded by the discovery of species not only new to us but heretofore never reported from the state or meagerly reported upon at best. In some cases cetrain species are only known from a single specimen which has been lost or misplaced. It has become increasingly difficult to discover new species and forms from the state due to the extensive building programs and so called improvements that have destroyed many of the best ecological areas. Add to this the widespread and indiscriminate use of pesticides and you have a very dim picture of butterflies indigenous to Maryland. There has been a gradual decline in the butterfly population throughout the last ten years and unfortunately it seems to be getting progressively worse.

The Wood Nymphs *Cercyonis pegala alope* (Fabricius) and *Cercyonis pegala maritima* (Edwards) have been reported from Maryland by Clark (1932). Specimens of *Ceronyis p. alope* that are found on the Inner and Outer Coastal Plain of the state fall into a cline that reaches its climax along the Atlantic Coast proper. In this area adjacent to the ocean and its beaches the subspecies *Cercyonis pegala pegala* (Fabricius) is dominant. A series of specimens captured here by the authors are inseparable from a large series of *C. p. pegala* in the Franklin Chermock collection from the Coastal Plain of the Carolinas.

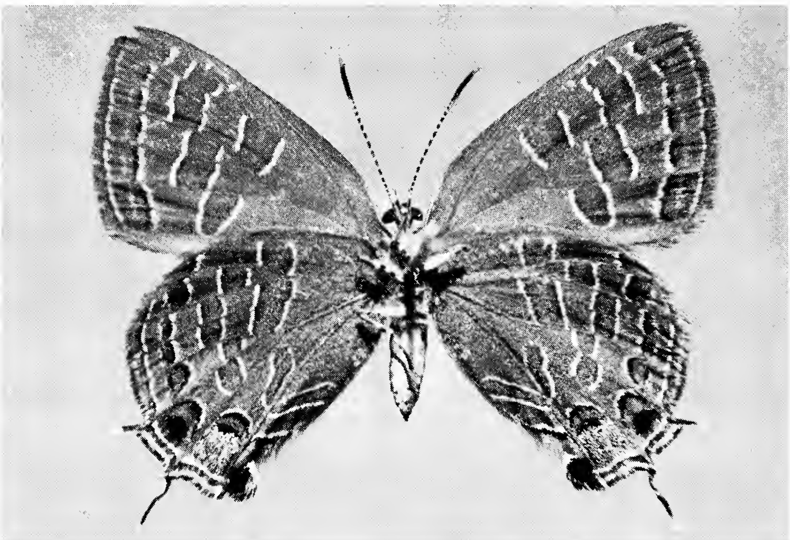


Fig. 1.—*Strymon liparops strigosus,* X4. Female venter; forewing length 14 mm. Near Odenton, Anne Arundel Co., Md., July 7, 1950.
Fig. 2.—*Feniseca tarquinius tarquinius,* X4. Dorsum; forewing length 15 mm. Near Fort Meade, Anne Arundel Co., Md., August 7, 1950. Black areas extensive, with reduction in orange; black submarginal spots of hindwing especially extensive or fused.

Collecting in the mountains of western Maryland has been productive in several areas where we netted a series of *Ceryonis* (Scudder). When these specimens were first captured we thought we had really hit it big with something new and undescribed. However, our old friend, Frank Chermock, again came to our rescue and showed us a series of *Ceryonis pegala nephele* (Kirby) in his collection. Our mountain species were inseparable from this subspecies. Since the species does undergo great clinal variation it is debatable whether one can justifiably designate the western Maryland species as true *C. p. nephele*. However, it should nevertheless be reported that this color form does occur in local colonies in the mountains and for the time being be designated as *Cercyonis pegala* form *nephele*.

A. H. Clark (1932) lists the Silver Bordered Fritillary, *Boloria selene myrina* (Cramer), from Beltsville, Maryland. However, he later described this as a new subspecies, *Bolaria selene marilandica* (Clark, 1941) from these specimens and gave the type locality as Beltsville. Therefore, *Bolaria selene myrina* has not been reported from Maryland.

This subspecies is found north and west of the Fall Line and has been collected in at least five counties. Although not common, it can be found in colonies and a series can be collected once the colonies are located. This species seems to prefer open, grassy, boggy areas that contain sedges, violets, and some water but are not overgrown. They do not stray far from these wet locales. There are two broods and a partial third. The first brood occurs in late May and early June. The second brood flies in July and the remnant of a third brood is on the wing in early September.

Clark and Clark (1951) first published the capture of the Silvery Checkspot, *Melitaea nycteis nycteis* (Doubleday) at Cabin John, Maryland by T. B. Blevins. Since that time most of the Blevins Collection has unfortunately been lost and along with it the *M. n. nycteis*. Clark at the time considered this species quite rare. However, the authors had collected this species extensively before the Blevins capture. *M. n. nycteis* has a wide range in Maryland occurring from the mountains to the Coastal Plains. It is far more common in the Piedmont and mountain areas. We have found several colonies on the Coastal Plain in Charles County. This species has two broods a year, which are from late May to early June, and from late July to early August.

In Maryland this butterfly seems to prefer shrubby areas, open areas near woods, and wet open woodland glades where the foodplant occurs.

Although the Coral Hairstreak, *Styrmon titus mopsus* (Hubner), has been known from many localities in Maryland, the northern counterpart, *Strymon titus titus* (Fabricius), has not been reported. *S. t. mopsus* ranges throughout southern and eastern Maryland occupying the Coastal Plains and part of the Piedmont area. As the species travels west and north into the mountains a cline occurs that reaches an extreme in western Maryland. Specimens have no white pigment whatsoever around the black spots on the underside of the hind wings and represent *Strymon titus titus.* This species has one generation a year which usually flies in July.

The Gray Hairstreak, *Strymon melinus humuli* (Harris), occurs throughout Maryland. Several specimens captured on the Outer Coastal Plain adjacent to the Atlantic Ocean represent *Strymon melinus melinus* (Hubner). Compared to Florida specimens they seem identical. This area of Maryland probably represents the northern extreme of the southern cline. Successive broods fly from early April through early September.

The Northern Hairstreak, *Strymon ontario ontario* (Edwards), has long been considered a rare butterfly everywhere in its range. The only published record for Maryland was by Clark and Clark (1951) where they cite a single capture by W. H. Wagner in White Oaks, Maryland on June 17, 1942. We have collected this species in eight counties and in two of these counties captures have been made every year for at least ten years thereby indicating that the species can become well established and not necessarily an intermittant emigrant. One important item of interest concerns the flight pattern in Maryland which is usually slightly earlier than *Strymon liparops strigosa* or *Strymon falacer falacer* (Godart). In any given area where these three species occur together, the *S. o. ontario* are always very stale and worn by the time fresh individuals of the other two species emerge.

There is weak evidence that *S. o. ontario* has a vestigal first brood in Maryland since we have two records of May 4, 1952 and April 18, 1968. The main brood flies from June to July.

A female *Strymon liparops strigosa* (Harris), the Striped Hairstreak, was collected in Hyattsville, Maryland by Warren Herbert Wagner, Jr. on June 10, 1935. This rare little butterfly

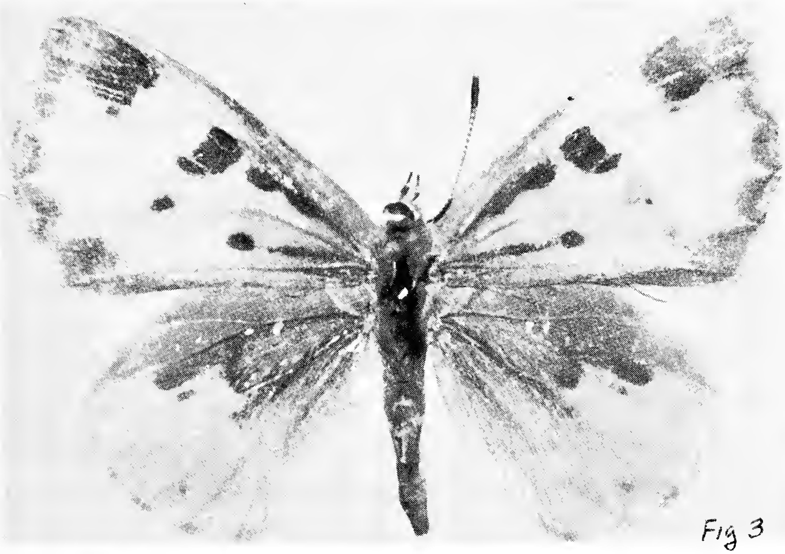


Fig. 3.—*Feniseca tarquinius nova-scotiae,* X4. Dorsum of worn specimen; forewing length 17 mm. St. Johns, Newfoundland, June, 1929. Black areas very reduced, with extension of orange; black submarginal spots of hindwing especially reduced.

Fig. 4.—*Feniseca tarquinius,* form *nova-scotiae,* X4. Dorsum of fresh specimen; forewing length 17 mm. Foxville, Frederick Co., Md., April 28, 1955. Despite extensive individual variation in this species, Figures 3 and 4 are nearly identical and, without the data could be suspected of originating from the same locality.

seemed to elude Maryland collectors for years. However, concentrated field work throughout the state has produced records from almost every county. This species is never abundant in Maryland and is no doubt the most overlooked species in the state. Probably the greatest factor in the passing over by collectors of this species is their secretive feeding habits. In nine out of ten instances this species prefers to feed on the flowers of Red Milkweed and Indian Hemp. However, the butterfly loves to feed on those blossoms which are concealed from view or buried in the surrounding vegetation. The casual collector would surely miss this species. On many occasions such a concealed specimen can be very cautiously approached by a cyanide jar effecting a capture far more easily than the swing of a net.

While investigating mountainous areas along Catotin Ridge in Frederick County for new forms on April 28, 1955, a small colony of *Feniseca tarquinius tarquinius* (Fabricius), the Harvester, was discovered. The color pattern appeared strange and atypical. They were again taken to Frank Chermock for comparison with the extensive material he had in his collection. Our specimens were perfect replicas of specimens he had from Nova Scotia representing the subspecies, *Feniseca tarquinius novascotiae* (McDunnough).

On May 12, 1955, another colony was found in the mountains of Allegany County. These specimens were also *novascotiae*—like in character. Our friend Frank Chermock netted a similar series on April 27, 1957, near Ice Mountain, West Virginia.

One cannot justifiably call these specimens *F. t. novascotiae* since they are quite a distance south of the normal range. However, all of these mountain specimens from the spring brood cannot be separated from typical *F. t. novascotiae* and probably in some manner represents a temperature induced form. If so, then the ecological conditions in the mountains of Maryland during spring could be similar to those where *F. t. novascotiae* is typically found. On this basis it is not so surprising to find a form paralleling *F. t. novascotiae* existing in the mountains of Maryland representing the spring brood. Until detailed research can solve this apparent problem we will go on record reporting this spring color pattern as merely a form and not a subspecies.

Warren Herbert Wagner, Jr. reported the capture of a single fresh male of *Lycaena thoe* (Guerin-Meneville), the Bronze

Copper, on July 22, 1934, from Beltsville, Maryland. This rare butterfly was not observed again in Maryland until June 6, 1949 when the authors captured a small series near Eklo, Baltimore County. This prompted a detailed search of the state for this species. During the next few years we secured specimens from fourteen counties in the state. The range of *L. thoe* in Maryland extends throughout the state. The only areas where we have not recorded it as yet are western Maryland and the southern Inner Coastal Plain. We have some records from the Outer Coastal Plain, Eastern Shore that fringe the salt marshes, and tidal areas. *L. thoe* is triple brooded in Maryland, being found in June, July, and September.

Thorybes confusis (Bell), the Confused Cloudy Wing, has not been reported from Maryland. However, all through its range it has been confused with *Thorybes pylades* (Scudder), the Northern Cloudy Wing, and often overlooked. We have records from eight counties and it is probably statewide in occurence. There are two broods a year which fly the first of June and the beginning of August.

One record was published for the capture of the Southern Sooty Wing, *Staphylus mazans hayhurstii* (Edwards), in Maryland by W. H. Wagner, Jr. from near Beverly Beach in Anne Arundel County. We have captured this species in sixteen counties from the Coastal Plains and Piedmont regions. This butterfly for many years seemed to be confined to salt marshes and tidal areas. However, in recent years it has penetrated the Piedmont and seems to be following the river flood plains. They usually prefer shady wooded areas and will not hesitate to fly directly into and weave through very heavy underbrush. Often they will rest in the middle of a large green leave with their wings held horizontal. There are two broods a year which occur from May to June, and from July to August. The winter is spent as a hibernating larva in a hibernacula usually made by sewing two leaves together.

Erynnis baptisiae (Forbes), the Wild Indigo Dusky Wing, has not been reported from Maryland. This species has been reported common by many workers throughout its range. For many years we had very few records for this butterfly in Maryland and considered it a rare species and a good catch. In the spring of 1960 we were fortunate enough to observe a female laying eggs on the food plant *Baptisia tinctoria* (Wild Indigo). From this observation we learned how to find the eggs and larva. Detailed research throughout the state produced new records

from at least seventeen counties. However, the butterflies were obtained by raising eggs or larva through to adults. Very few adults were seen in the field much less captured. In Maryland this species is extremely difficult to obtain as adults but with effort can be obtained by raising the larva which are easier to collect.

There are two distinct broods in Maryland. The first brood flies the last week of May to the first week of June. The second brood flies the last week of July through the first two weeks of August.

Erynnis zarucco (Lucas), the Zarucco Dusky Wing, has been observed many times in the field in southern Maryland but has been difficult to catch. The fast erratic flight pattern makes it a tough target. However, on September 11, 1958, a perfect specimen was finally netted near Turner in Saint Mary's County for a new state record. This specimen was identified by Dr. John Burns.

Leonard's Skipper, *Hesperia leonardus leonardus* (Harris) has been reported from Maryland (Clark 1932). Specimens from the mountains of western Maryland display spots beneath the hind wings that are very dark and ochreaus. This form represents the subspecies *Hesperia leonardus stallingsi* (H. A. Freeman), and has been collected in at least two counties. There is one brood a year that flies from the last of August to the first of September.

Field studies carried out on the Eastern Shore of Maryland were very productive on July 12, 1962. Several colonies of the rare Alabama Skipper, *Euphyes dion alabamae* (Lindsey), were discovered in the extensive marsh and wetlands of Dorchester County. An extensive search was begun to find more colonies of this elusive butterfly. On July 29, 1965, several small colonies were discovered further south in Worchester County.

Specimens were observed and collected in a sedge-like grass that grew to four feet in wet areas. Occasionally a male would select a high perch overlooking the tall grass from which he would dart out at any passing insect. After driving off the intruder, the male would fly back and forth over his restricted flyway and settle back on his original perch with his wings tilted at a forty-five degree angle. Most of the specimens, both male and female, were content to stay quite low in the grass and when disturbed would zig-zag through it in a *Poanes viator* (Edwards) manner. This type of flight pattern made capture difficult.

The Two Spotted Skipper, *Euphyes bimacula* (Gorote and Robinson), was reported by A. H. Clark (1934, 1935) on the basis of one specimen from Cabin John, Montgomery County, Maryland. This skipper seems to be rare everywhere in its range. In Maryland it is confined to open boggy areas that are not overgrown. Diligent field work has turned this species up in four other counties: Baltimore, Howard, Garrett, and Frederick. We have never discovered a populous colony. Most locales produce one or two specimens and rarely more a year. These same areas are checked annually with the same results except that in some years none are seen. This species probably has a much wider range in Maryland. There is one generation a year that has a flight period from June to July.

One specimen of *Panoquina ocola*, the Ocola Skipper, was reported collected in Silver Spring, Maryland on September 7, 1931, by Clark (1932). This species is found regularly every year but is never common. In early summer it is rare, and as the summer progresses the butterfly increases in numbers. By September and October it has reached its maixmum abundance where in proper locales four or five can be netted in a day's collecting. We have found it in seven counties.

Briefly summarized with early and late captures along with some of the new data and range extensions for Maryland are:

SPECIES	DATE	LOCALITY
1. *Cercyonis p. pegala*:	7-18-57	Ocean City, Worchester Co.
	8-15-68	Girdle Tree, Worchester Co.
2. *Cercyonis p.* form *nephele*:	VII-14-60	Green Ridge State Forest, Allegany Co.
	VII-31-58	Savage River State Forest, Garrett Co.
3. *Boloria s. myrina*:	VI-17-50	Sang Run, Garrett Co.
	IX-19-66	Thurmont, Frederick Co.
4. *Melitaea n. nycteis*:	VI- 7-62	Ironsides, Charles Co.
	VIII-27-46	Woodstock, Baltimore Co.
5. *Strymon t. titus*:	VII-17-56	Grantsville, Garrett Co.
	VII-26-55	Green Ridge State Forest, Allegany Co.
6. *Strymon m. melinus*:	VII-18-57	Ocean City, Worchester Co.
	VI-29-63	Beaver Dam, Worchester Co.
7. *Strymon o. ontario*:	IV-18-68	Hebbville, Baltimore Co.
	VI-23-61	Blackwater National Wildlife Refuge, Dorchester Co.
8. *Strymon l. strigosa*:	VI- 7-62	Doncaster State Forest, Charles Co.
	VII-18-62	Big Savage Mountain, Garrett Co.

9. *Feniseca t.* form *novascotiae*:	IV-28-55	Cunningham Falls State Park, Frederick Co.
	V-12-55	Green Ridge State Forest, Allegany Co.
10. *Lycaena thoe*:	VI- 6-49	Eklo, Baltimore Co.
	VII-16-53	Kent Island, Queen Annes Co.
	IX-24-70	Bestpitch, Dorchester Co.
11. *Thorybes confusis*:	VI- 9-50	Fort Meade, Anne Arundel Co.
	IX- 3-63	Soldiers Delight, Baltimore Co.
12. *Staphylus m. hayhurstii*:	V-28-70	Soldiers Delight, Baltimore Co.
	IX-15-57	Great Falls, Montgomery Co.
13. *Erynnis baptisiae*:	V-29-58	Eklo, Baltimore Co.
	VII-11-60	Welcome, Charles Co.
14. *Erynnis zarucco*:	IX-11-58	Turner, St. Mary's Co.
15. *Hesperia l. stallingsi*:	IX-10-52	Oakland, Garrett Co.
16. *Euphyes d. alabamae*:	VII-12-62	Newbridge, Dorchester Co.
	VIII-27-63	Blackwater National Wildlife Refuge, Dorchester Co.
17. *Euphyes bimacula*:	VI- 8-53	Hebbville, Baltimore Co.
	VII-17-56	Wolf Swamp, Garrett Co.
18. *Panoquina ocola*:	VII-15-52	Severna Park, Anne Arundel Co.
	IX-13-60	Liverpool Point, Charles Co.

LITERATURE CITED

CLARK, A. H., (1932). The butterflies of the District of Columbia and vicinity. *U.S. Nat. Mus. Bulletin* 157: 68-71 (*Cercyonis*).

________ (1932). The butterflies of the District of Columbia and vicinity. *U.S. Nat. Mus. Bulletin* 157: 102-104 (*B. myrina*).

________ (1932). The butterflies of the District of Columbia and vicinity. *U.S. Nat. Mus. Bulletin* 157: 218-219 (*E. leonardus*).

________ (1932). The butterflies of the District of Columbia and vicinity. *U.S. Nat. Mus. Bulletin* 157: 233 (*P. ocola*).

________ (1934, 1935). *Atrytone bimacula* recorded from the District of Columbia area. *Proc. Ent. Soc. Washington,* 36 (8, 9): 263.

________ (1941). A new subspecies of *Brenthis myrina*. *Jour. Wash. Acad. Sci.* 31, (9): 384.

CLARK, A. H. and L. F. CLARK, (1951). The butterflies of Virginia. *Smithsonian Miscell. Collection.* 116, (7): 47-48 (*M. nycteis*).

________ (1951). The butterflies of Virginia. *Smithonian Miscell. Collection.* 116, (7): 80 (*S. o. ontario*).

SIMMONS, R. S., (1957). Contribution No. 1. Notes on Maryland Lepidoptera. Notes on ten new butterfly records for the state of Maryland. *Lepid. News* 10 (5): 157-159.

SIMMONS, R. S. and W. A. Andersen, (1962). Contribution No. 2. Notes on Maryland Lepidoptera. Notes on five new butterfly records for the state of Maryland. *Jour. Lepid. Soc.* 15 (2): 99-101.

SIMMONS, R. S., (1963). Contribution No. 3. Notes on Maryland Lepidoptera. Nine new butterfly records for the state of Maryland. *Jour. Lepid. Soc.* 17 (2): 107-109.

WAGNER, WARREN HERBERT, JR., (1941). District of Columbia butterfly notes. *Ent. News,* 53: 200 (*L. thoe*).

________ (1941). District of Columbia butterfly notes. *Ent. News,* 53: 199 (*S. l. strigosa*).

________ (1941). District of Columbia butterfly notes. *Ent. News,* 53: 246 (*S. hayhurstii*).

Journal of Research on the Lepidoptera 9(3): 185-190, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

SYNAXIS MOSESIANI SALA; A NEW *SYNAXIS* FROM SOUTHERN CALIFORNIA

FRANK P. SALA

3830 Carnarvon Way, Los Angeles, California 90027

THE GENUS Synaxis is well-represented in southern California, but relatively little-known because all species but one are active adults in the latter part of autumn, the lone exception being *Synaxis cervinaria.* Pack., which flies in June. The arrival of October is the signal for *S. hirsuitaria* B. & McD. to break its summer diapause. Along with the bulk of the October-active insects, it is taken at light in this period. November is the chosen time for *S. formosa* Hulst, and for this reason it is less well-known in collections.

But the end of November and early December is yet another discrete seasonal period which yet another member of the *Synaxis* has chosen as its own. This species is unlike any of the others, but may be confused with both S. *cervinaria* and *S. hirsuitaria,* which it superficially resembles. It has escaped notice, in all probability because of its singular period of flight; early in the dusk of Nov. and Dec. evenings just prior to the first rains of the winter in southern California.

Synaxis mosesiani sp. nov.

Synaxis mosesiani; ranges throughout the lower chaparral belt (elevation 2000-3000 feet) of southern California, where its chosen foodplant, *Lonicera hispidula* Douglas (California honeysuckle), occurs. Thus, bases of canyons opening to the coastal, western flatlands are the places to find this species, on the wing in late November and early December.

Male: Head with vertex tan; palpi tan; eyes black; tongue light tan, functional; antennae filliform, but with outer margin of antennal segments serrate, giving an appearance distinct from all other California *Synaxis.* Thorax tan above and below, clothed throughout with hairy scales, darker dorsad; legs tan to distal

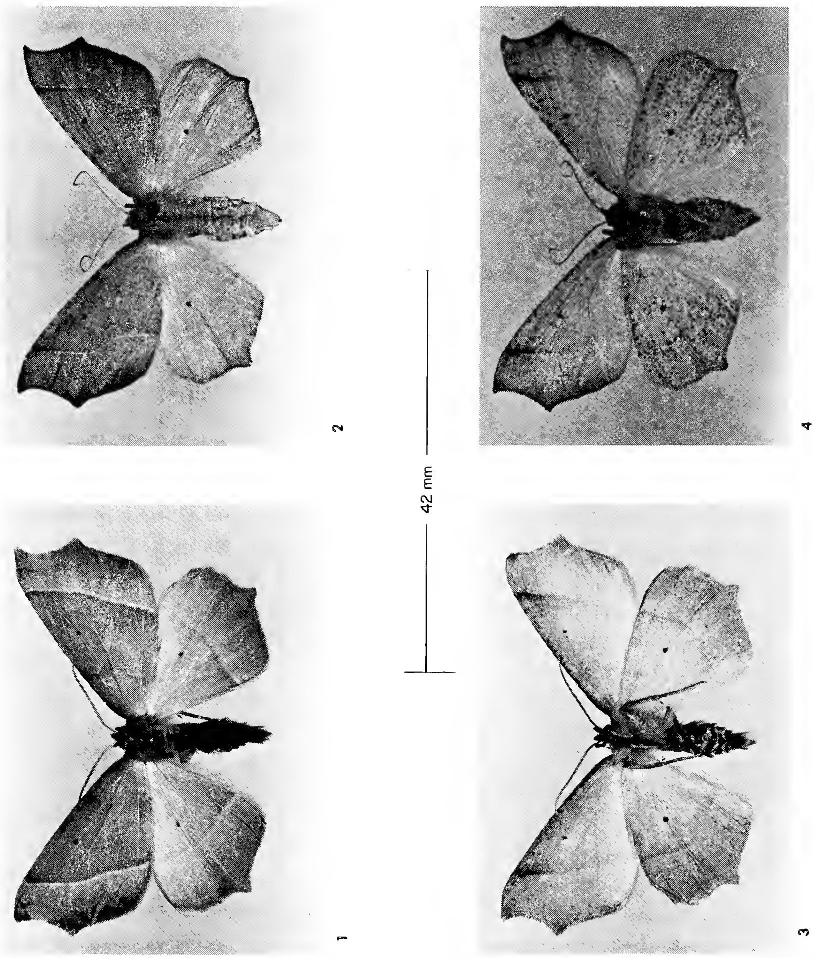


Fig. 1.—*Synaxis mosesiani* sp. nov., Holotype male, upper facies.
Fig. 2.—*Synaxis mosesiani* sp. nov., Allotype female, upper facies.
Fig. 3.—*Synaxis mosesiani* sp. nov., Holotype, lower facies.
Fig. 4.—*Synaxis mosesiani* sp. nov., Allotype, lower facies.

joint of femur, then black to tips of tarsal joints, whitish ring of scales at joints, metathoracic legs lighter than other four. Abdomen unicolorous tan, darker dorsad.

Upper surfaces of Wings — primaries: Ground color is unicolorous tan-brown (occasional specimens have a deep russet overlay of color; these forms look like-resemble S. *cervinaria*); basic wing shape and outline are typical of the genus, being angulate on distal margin, outer margin area extended at terminus of vein M-1; t.a. line usually present as an indistinct shading of darker scales, perpendicular to anterior margin, angled mesad with apex at M-1, continuing irregularly to terminus perpendicular to anal margin (some specimens have t.a. line as indistinct entity to only suggested); t.p. line is always present, being a line approximating a parallel to the outer margin, if it (the margin) were not angulate, straight to M-1, then curved, first mesad, then distad, to terminate at curve of anal margin, coloring darker mesad to lighter distad throughout; discal mark is a finely discrete black-brown spot, quite faint on some specimens; s.t. line is represented by a few scattered black scales near apical margin, often not represented at all.

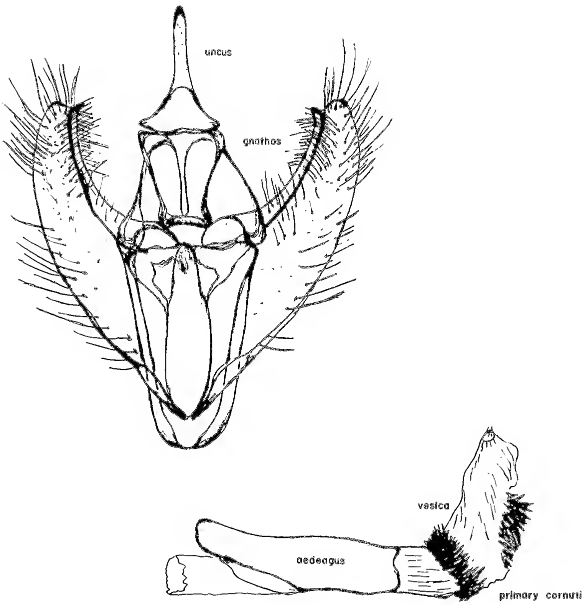
Upper surface of wings — secondaries: Ground color tan, lighter than primary, unicolorous; t.p. line is only maculation, often incomplete to occasionally only suggested; discal spot always present, black, elongate-round.

Lower surface of wings — primaries: Ground color tan, lighter than upper surface, especially in overlap areas, peppering of black scales (especially in the russet form), darker along costal margin; t.a. line absent; t.p. line always present, often indistinct on posterior third of wing; discal spot always present, but less distinct than on upper surface.

Lower surface of wings — secondaries: Ground color much same as darker portions of primaries, peppering of black varies from none to very marked; t.a. line absent; t.p. line present, often incomplete posteriad; discal spot present, black, round, often more pronounced than at all other locations.

Length of Span of Wings: 41 to 43 mm, measured across tips of angulate apex of distal margin (note scale and figures 1 - 4.); holotype 41mm.

Female: Head like male except for antennae, which are more filliform, and segment serrations are less distinct. Thorax same. Abdomen shows some peppering of black scales, especially when full of eggs.



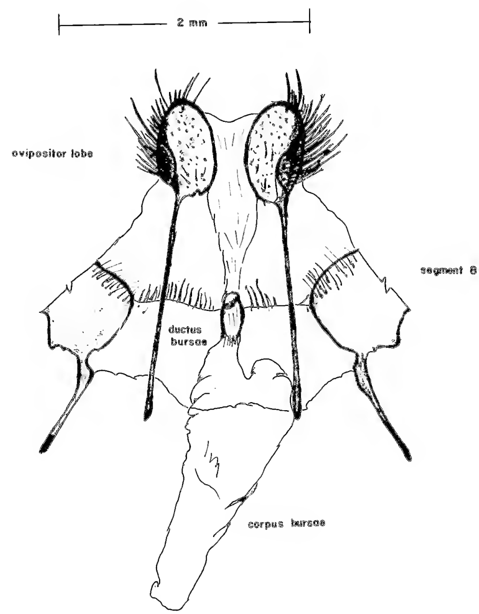


Fig. 5.—a. *Synaxis mosesiani* sp. nov., male genitalia (aedeagus removed), b. aedeagus, vesica expanded.
Fig. 6.—*Synaxis mosesiani* sp. nov., female genitalia.

Upper surface of wings — primaries: Ground color much same as male, always with some traces of tauny scaling, and contrasting of color less than for the male; t.a. line indistinct to absent; t.p. line always present, but often incomplete — always less well defined than on the male, always more wavy; discal spot always present subequal to that of male.
Upper surface of wings — secondaries: Ground color tan, lighter than primary, unicolourous; t.p. line is only maculation, is often incomplete occasionally only suggested; discal spot present, black, elongate-round.
Lower surface of wings — primaries: Ground color tan, darker on anterior two thirds, flecked with peppering of black scale spots, less where secondaries overlap, generally moreso than for the male; t.a. line absent; t.p. line present on anterior third only, occasionally absent; discal spot present, black, round.
Lower surface of wings — secondaries: Ground color tan, without maculation, save for variable peppering of black patches of scales which are very noticeable in some specimens; discal spot black, always present.
Length of span of wings: 40.5 mm (allotype), varies highly to a minimum of 34 mm for collected imagines, usually smaller than male.
Male genitalia (fig. 5): Uncus elongate to rounded point, triangulate at base, concave on ventral surface; gnathos oval-quadrate, widest posteriad; valves elongate, tapering to rounded tip, well sclerotized, with spinelike tip on median apex; aedeagus (1.45-1.50mm lg.) tapered to rounded anteriad, no secondary cornuti; vesica "L" shaped, with ring of primary cornuti at joint of bend, and additional cluster near terminus.
Female genitalia (fig. 6): segment 8 incompletely sclerotized on dorsal hemisphere; ovipositor lobes strongly sclerotized, ovate, well spined; ductus bursae lightly sclerotized, constricted; corpus bursae a conical sac without distinctive characters.
Early Stages:

These are now known for this species, but will be described in detail in a subsequent publication. The cycle is one typical of many species which are active in the autumn of the year. The eggs, laid by the adult in late November-early December, remain as eggs until the following spring. The larva feeds through without pause to maturity. Pupation, in a loose silk cocoon on the surface of the ground, occurs by early summer, remains so until the November period of emergence of the imago.

TABLE 1

Synaxis mosesiani sp. nov.

List of Paratypes, with data

Paratype no.	Date collected	Location	Sex	Collection location
1	XI-18-1947	So. Pasadena, LA Co. Calif.	f	FPS
2 Emgd.	IX-06-1950	Little Daltons Cn., LA Co.	m	FPS
3 Emgd.	X-26-1950	" " " "	f	LACM
4 Emgd.	X-03-1950	Big Daltons Cn., "	m	FPS
5 Emgd.	X-05-1950	" " " "	m	LACM
6 Emgd.	X-14-1950	" " " "	m	LACM
7 Emgd.	XI-05-1962	" " " "	f	AMH
8	XII-09-1963	Carnavon Way, LA Co Calif.	m	AMH
9	X-24-1967	" " "	m	Cornell
10	XII-03-1967	" " "	m	UCB
11	XI-08-1968	" " "	m	USNM
12	X-29-1966	" " "	f	Cornell
13	XI-19-1966	" " "	f	FPS
		(conf.; eggs; code=11196601)		
14 Emgd.	V-22-1967	" " f-1 of 11196601	f	USNM
15 Emgd.	VIII-27-1967	" " " "	f	UCB
16 Emgd.	IX-11-1967	" " " "	f	FPS
17 "	IX-12-1967	" " " "	m	FPS
18 "	IX-16-1967	" " " "	f	FPS
19 "	IX-20-1967	" " " "	m	FPS
20 "	IX-24-1967	" " " "	f	FPS
21 "	IX-29-1967	" " " "	f	LACM
22 "	IX-27-1967	" " " "	f	LACM
23 "	IX-24-1967	" " " "	f	Yale
24 "	IX-24-1967	" " " "	m	Yale
25 "	IX-25-1967	" " " "	f	Cal Acad
26 "	X-02-1967	" " " "	f	FPS
27 "	X-06-1967	" " " "	f	FPS
28 "	X-06-1967	" " " "	f	FPS
29 "	IX-30-1967	" " " "	f	FPS
30 "	IX-29-1967	" " " "	m	Cal Acad
31 "	XI-01-1967	" " LA Co Calif.	f	FPS
		(conf.; code = 11016701)		
32 "	VII-16-1968	" " f-1 of 11016701	f	FPS
33 "	IX-10-1968	" " " "	m	FPS
34 "	IX-28-1968	" " " "	m	FPS
35 "	IX-30-1968	" " " "	m	FPS

Foodplants:
Lonicera hispidula, (Lab) *Ceanothus divaricatus* Nutt., *Salix laevigata.* The latter two plants were offered to larvae in the laboratory; neither has been known to be used as a host in the field.

Distribution:
Known from the Santa Monica Mts. (Griffith Park area of Los Angeles, Calif.); from the lower Big Dalton's Cn. and adjoining Little Dalton's Cn., Los Angeles County area. Probably ranges throughout the foothill canyon area of the Coastal and intermediate Ranges of southern California.

Types:
Holotype: (male)

Carnavon Way, Los Angeles 90027, LA County, Calif. Emgd. Sept. 22, 1967, (F. P. Sala, coll).; LACM.

Allotype: (female)

Carnavon Way, Los Angeles 90027, LA Co. Calif. Emgd. Aug. 29, 1967, (F. P. Sala, coll.); LACM.

There are 35 paratypes included in the type series, in addition to the holotype and allotype. These have been listed on Table I along with their labeled data, and the location where each is to be deposited.

The species is named in honor of my good and valued friend, Mr. Burton Mosesian, of Los Angeles, California, who has from time to time inspired my work in entomology, and whose special appreciation of the art of collecting insects warrants a species bearing his name.

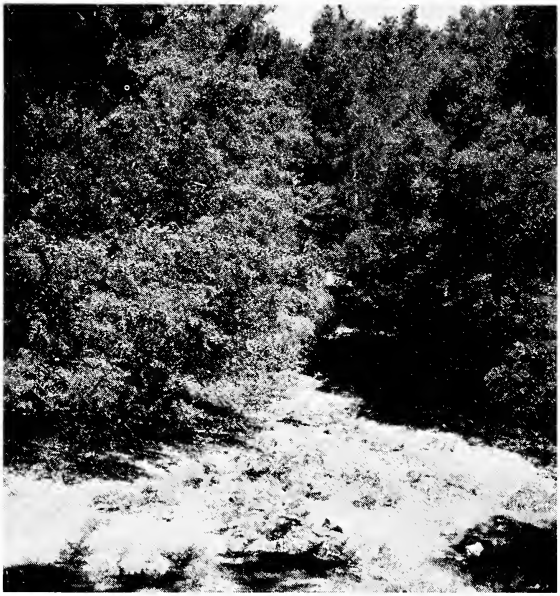
Grateful acknowledgement is due to Mr. Carl Kirkwood, of Summerland, California, who generously donated his notes of related species of the genus *Synaxis* when these were being reviewed. Mr. Ronald Leuschner, of Los Angeles, California, also generously made available his data on related species. Dr. Charles Hogue, Senior Curator of Entomology at the Los Angeles County Museum assisted with the preparation of the genitalia, and made available the special equipment of the Museum to record the genitalia.

BIBLIOGRAPHY

BARNES & McDUNNOUGH, 1913. Contributions Vol. II, no. 1, p. 131.
————, 1916. Contributions Vol. III, p. 33.
HOLLAND, W. J., 1903. The Moth Book. p. 351.
HULST, G. W., 1896. *Trans. Amer. Ent. Soc.*, vol. XXIII, p. 374, 375.
PACKARD, A. S., 1871. *Proc. Bost. Soc. Nat. Hist.*, vol 13, p. 386.
————, 1874. *Proc. Bost. Soc. Nat. Hist.*, vol. 16, p. 34.

HABITAT—*ARGYNNIS ADIASTE*

(Continued from page 168)



NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distributional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W.J. Reinthal and J.T. Mithell. Send data to Dr. W.J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U.S.A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P.O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P.O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W.T.M. Forbes. Entomological Reprint Specialists. P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B.M. Endicott. Distributed in U.S.A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P.O. Box 433, New York, N.Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A.I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

Centurie de Lepidopteres de L'ile De Cuba. P.H. Poey, 1832. C.W. Classey, 353 Hanworth Road, Hampton, Middlesex, U.K. in the U.S.A. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif.

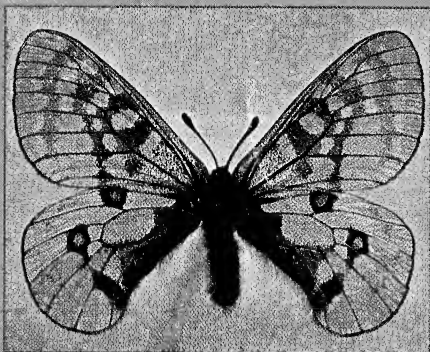
THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

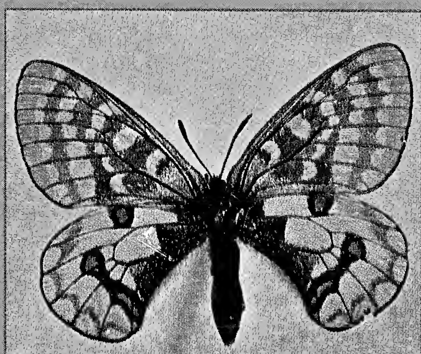
Volume 9 *Number 3* *September, 1970*

IN THIS ISSUE

COVER—VARIATION in white females of *Colias eurytheme* from the San Joaquin Valley of California. These are heterozygotes and possible homozygotes differing from the orange female by the single dominant gene. (Collected or bred, 1943-45). William Hovanitz

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA





Volume 9 *Number 4* *December, 1970*

// THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 9(4):193-214, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

THE HEAD CAPSULE OF SELECTED HESPERIOIDEA[1]

JACQUELINE Y. MILLER

Allyn Museum of Entomology, 712 Sarasota Bank Building, Sarasota, Fla.

INTRODUCTION

THE HIGHER CLASSIFICATION of the Hesperioidea has never been quite satisfactory despite the efforts of Scudder (1872), Watson (1893), Evans (1937, 1949, 1951, 1952, 1955) and others. Scudder included everything in the Hesperioidea under the "family" Urbicolae, a suprageneric name credited to Fabricius in 1793. The Hesperiidae comprised the main family in E. Y. Watson's (1893) classification because in the British Museum the Megathymidae and the Euschemonidae were arranged as part of the Heterocera (Castniidae). Lindsey, Bell, and Williams (1931) finally divided the Hesperioidea into three families: Megathymidae, Hesperiidae, and Euschemonidae. Evans (1949, 1955), however, considered the Euschemonidae to be part of the Pyrginae and the Megathymidae as a subfamily related to the Hesperiinae.

Morphological studies have been done on the papilionids, such as those of Ehrlich (1958a, 1958b), Ehrlich and Ehrlich (1962), and Crombach (1967). The only morphological study done on a hesperioid was by Ehrlich (1960) on *Epargyreus clarus* (Cramer), a pyrgine.

As part of the present study a complete sclerotic morphological survey was done on a few of the hesperioids. With the exceptions of wing venation, wing articulations, genitalia, and relative size differences, the greatest variation was in the ele-

---

[1]Based in part on a thesis submitted to partially fulfill the requirements for the degree of Master of Science, Catholic University of America, Washington, D.C., January, 1968.

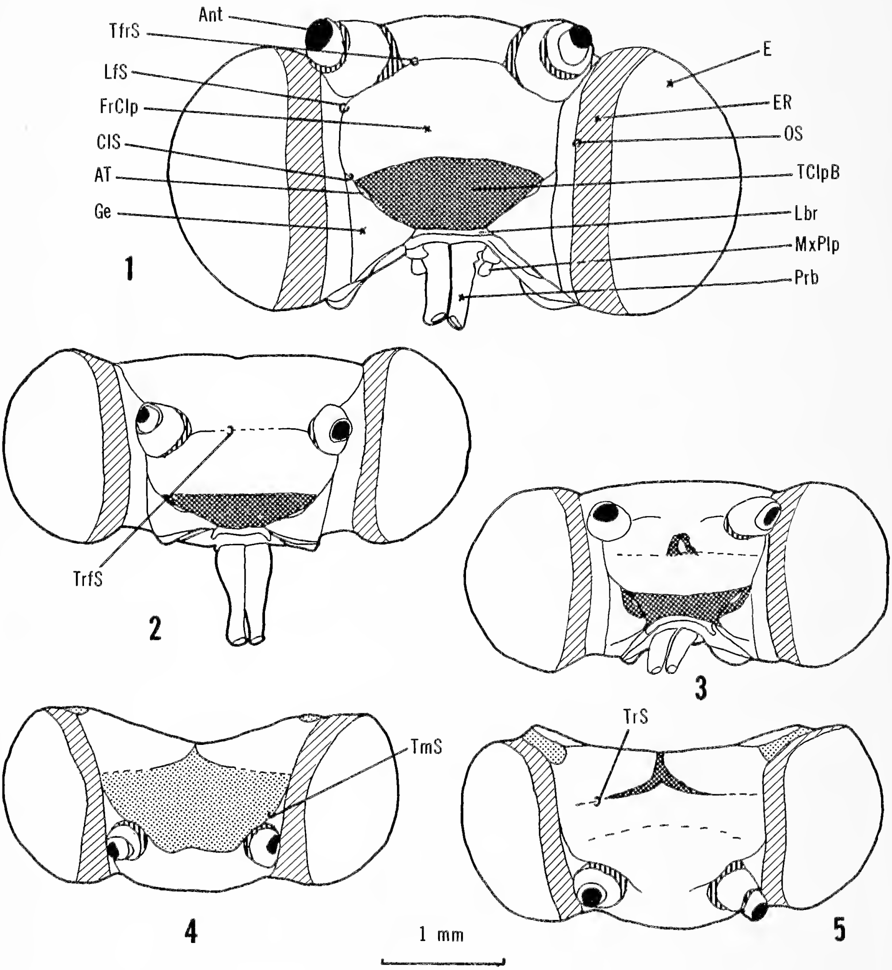


Fig. 1. *Megathymus yuccae,* anterior view. (Example of full transfrontal suture. Sclerotized patterns on frontoclypeus have been removed, see fig. 41.) 2. *Urbanus dorantes,* anterior view (Partial transfrontal suture). 3. *Tagiades flesus,* anterior view (ornamentation of transclypeal band around anterior tentorial pits). 4. *Pyrgus oileus,* dorsal view (simple transverse sutures). 5. *Tagiades flesus,* dorsal view.

ments of the head capsule. Such structures as the antennae and the labial palpi already described by Evans and others will not be discussed here.

The aim of the present study is primarily morphological, rather than taxonomic, but comparison of certain morphological characters may indirectly clarify the relationships of these various representatives phylogenetically. Since there were only a limited number of specimens available for dissection, no definite taxonomic conclusions will be drawn.

METHODS AND MATERIALS

Dried specimens or specimens preserved in 70% alcohol were used. No special differences were noted morphologically between material preserved in either manner. The head was removed, wetted with 70% alcohol and macerated in 10% KOH.

All dissections were made in wetting solution. Scales and heavy hair tufts were removed with probes. In order to observe some structures in detail, the heads were bleached in Clorox and the sclerites stained lightly in a weak mercurochrome solution.

Drawings were made using a Wild M-5 dissecting microscope equipped with a camera lucida.

The terminology used is primarily that of Snodgrass (1935), DuPorte (1946, 1956, 1957, 1959), Imms (1964), and Matsuda (1965).

Forty-one Hesperioidea were studied:

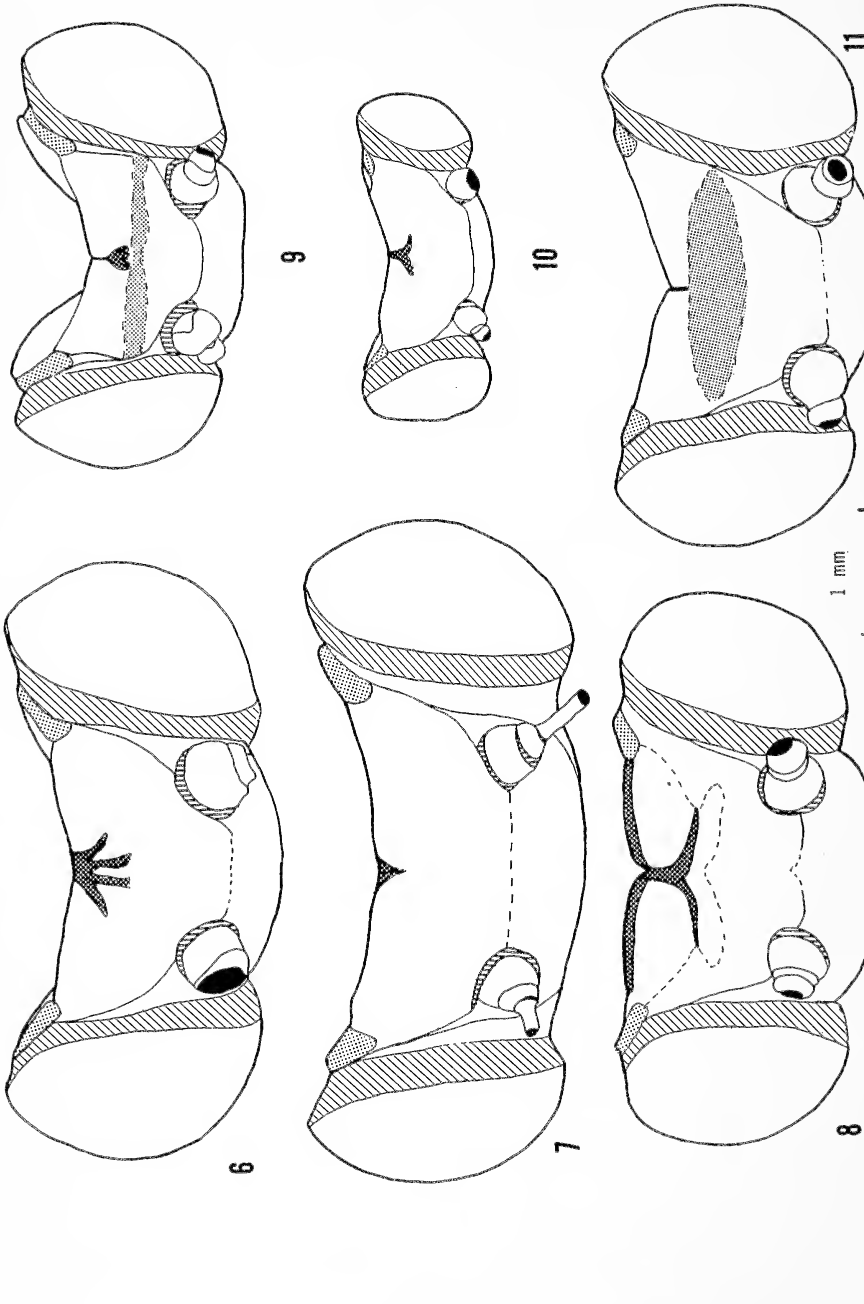
MEGATHYMIDAE: *Megathymus streckeri texana* Barnes and McDunnough, *Megathymus y. yuccae* (Boisduval and LeConte), *Agathymus n. neumoegeni* (Edwards), *Agathymus carlsbadensis* (Stallings and Turner).

HESPERIIDAE:

Hesperiinae: *Poanes viator* (Edwards), *Dalla cypselus evages* (Hewitson), *Vettius c. coryna* (Hewitson), *Quinta cannae* (Herrich-Schäffer), *Caenides dacela* (Hewitson), *Telicota colon argeus* (Plötz), *Panoquina sylvicola* (Herrich-Schäffer).

Trapezitinae: *Trapezites s. symmomus* (Hübner), *Hesperilla c. chrysotricha* (Meyrick and Lower), *Signeta flammeata* (Butler), *Motasingha a. atralba* (Tepper).

Pyrginae: *Phocides pigmalion* (Cramer), *Epargyreus clarus* (Cramer), *Urbanus d. dorantes* (Stoll), *Autochton cincta* (Plötz), *Sarmentoia p. phaselis* (Hewitson), *Celaenorrhinus f. fritzgaertneri* (Bailey), *Celaenorrhinus p. proxima* (Mabille),



Figs. 6-11: dorsal views of different types of transverse sutures. 6. *Agathymus carlsbadensis.* 7. *Hasora badra.* 8. *Mimoniades nurscia.* 9. *Caenides dacela.* 10. *Pyrgus adepta.* 11. *Staphylus ascaphalus.*

Celaenorrhinus galenus (Fabricius), *Spathilepia clonius* (Cramer), *Staphylus ascaphalus* (Staudinger), *Erynnis z. zarucco* (Lucas), *Pyrgus o. oileus* (Linnè), *Pyrgus communis adepta* (Plötz), *Tagiades flesus* (Fabricius), *Abantis paradisea* (Butler).

Coeliadinae: *Coeliades forestan* (Cramer), *Pyrrhochalcia iphis* (Drury), *Hasora b. badra* (Moore), *Badamia exclamationis* (Fabricius).

Pyrrhopyginae: *Pyrrhopyge araxes arizonae* (Godman and Salvin), *Mimoniades minthe* (Godman and Salvin), *Amenis baroni* (Godman and Salvin), *Mysoria affinis* (Herrich-Schäffer), *Myscelus p. phoronius* (Hewitson), *Mimoniades n. nurscia* (Swainson).

EUSCHEMONIDAE: *Euschemon r. rafflesia* (Macleay).

MORPHOLOGY OF THE HESPERIOID HEAD

The hesperioid head is well differentiated from that of the Papilionoidea by its relative width and widely separated antennae.

Eyes

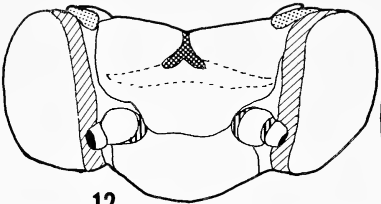
The most prominent feature of the hesperioid head are the compound eyes(E), which are entire and are bounded by the inner ocular sutures(OS).

Ehrlich (1960) described the hesperioid eye as being divided into two distinct areas: (1) a distal area composed of well developed facets, and (2) an inner eye ring (ER). This eye ring (fig. 1) is particularly evident in bleached specimens and occupies approximately one-fourth to one-third of the area of the eye. In all specimens studied the eye ring was evident and free on the inner edge. Internal examination showed that the eye ring is not an integral part of the head capsule and can be removed intact. Facets are evident over the entire eye upon removal of the eye ring. The nature, approximate size, and location of the eye ring were the same whether examined in fresh or preserved material.

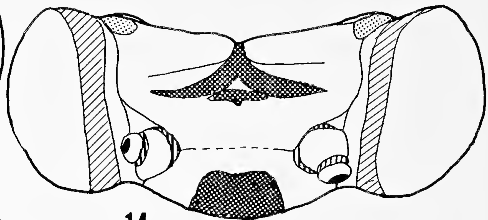
Face

The literature describing the specific morphological structures of the butterfly head, and particularly that of the face is rather confusing. Although there are fewer sclerites and sutures present than in the generalized insect head, the interpretation of such structures and their resulting terminology varies markedly with each author (Crombach, 1967).

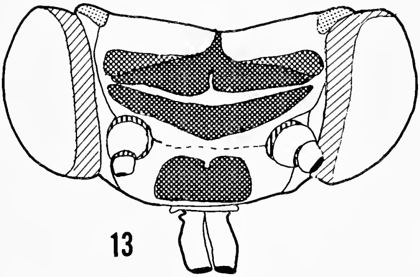
The face is defined as the anterior portion of the head between the compound eyes (fig. 1). The areas which delimit the



12



14

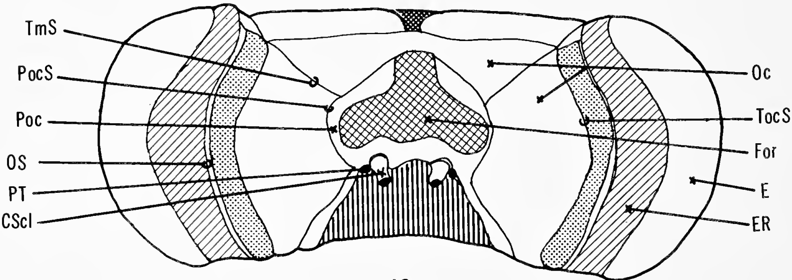


13

15

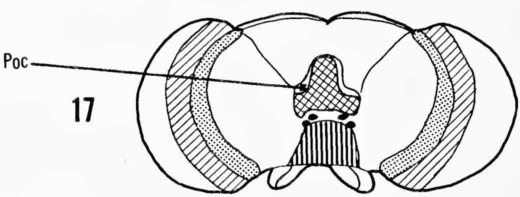
.5 mm

Fig. 15 only



16

1 mm



17

Fig. 12. *Celaenorrhinus proxima,* dorsal view. 13. *Quinta cannae,* dorsal view. 14. *Urbanus dorantes,* dorsal view. 15. *Urbanus dorantes,* enlarged internal view of sclerotized pattern on vertex. 16. *Megathymus texana,* posterior view. 17. *Celaenorrhinus galenus,* posterior view.

face are the paraocular areas or genae, the frontoclypeal sclerite (FrClp), and the dorsal frons.

Since there are marked differences in the various sutures in the hesperioid head, the term suture will be defined in the most stringent terms, *i.e.* a line or space separating two sclerotic areas of the cuticule, with a concomitant ridge evident on the inside of the head capsule.

The transfrontal suture (TrfS) interconnects the antennal sockets. This suture generally falls into one of the following three categories morphologically: a true suture (fig. 1), a partial suture (fig. 2) with a partial ridge occurring on either side internally, and a simple sulcus or line with no raised internal ridge. Table I shows the condition of this suture in the specimens examined. The transfrontal suture appears as a sulcus in members of various groups, but consistently in the Coeliadinae.

The laterofacial suture (LfS) extends from the edge of the antennal socket ventrolaterally to the labium. This suture is generally intersected at its midpoint by a U-shaped clypeolabral suture (ClS). The anterior tentorial pits (AT) lie along the clypeolabral suture and are interconnected by a heavily sclerotized transclypeal band (TClpB). In the Hesperiinae, Trapezitinae, Coeliadinae, Euschemonidae, and most of the Megathymidae examined, the anterior tentorial pits lie equidistant from the laterofacial suture and labrum (Lbr).

The anterior tentorial pits are closer to the labrum than to the intersection with the laterofacial suture in the remaining hesperioids studied. In the Pyrrhopyginae the latero-facial suture extends virtually from the intersection of the clypeolabral suture to the labrum. The anterior tentorial pits lie approximately one-fourth the distance between the intersection of the two sutures and the clypeolabral band in this group. In the Pyrginae the anterior tentorial pits lie medially n the clypeolabral suture with a few exceptions: these structures lie nearer to the labrum in *P. pigmalion, U. dorantes, P. adepta* (fig. 44), and *A. cincta.* The anterior tentorial pits are closer to the laterofacial suture in *C. galenus* and *A. paradisea.*

The transclypeal band is rather smooth in most of the specimens examined. In some cases the area around the anterior tentorial pits may be somewhat sclerotically ornamented, as in *T. flesus* (fig. 3).

Vertex

This region is delimited laterally by the temporal suture (TmS), which extends from the posterior part of the head

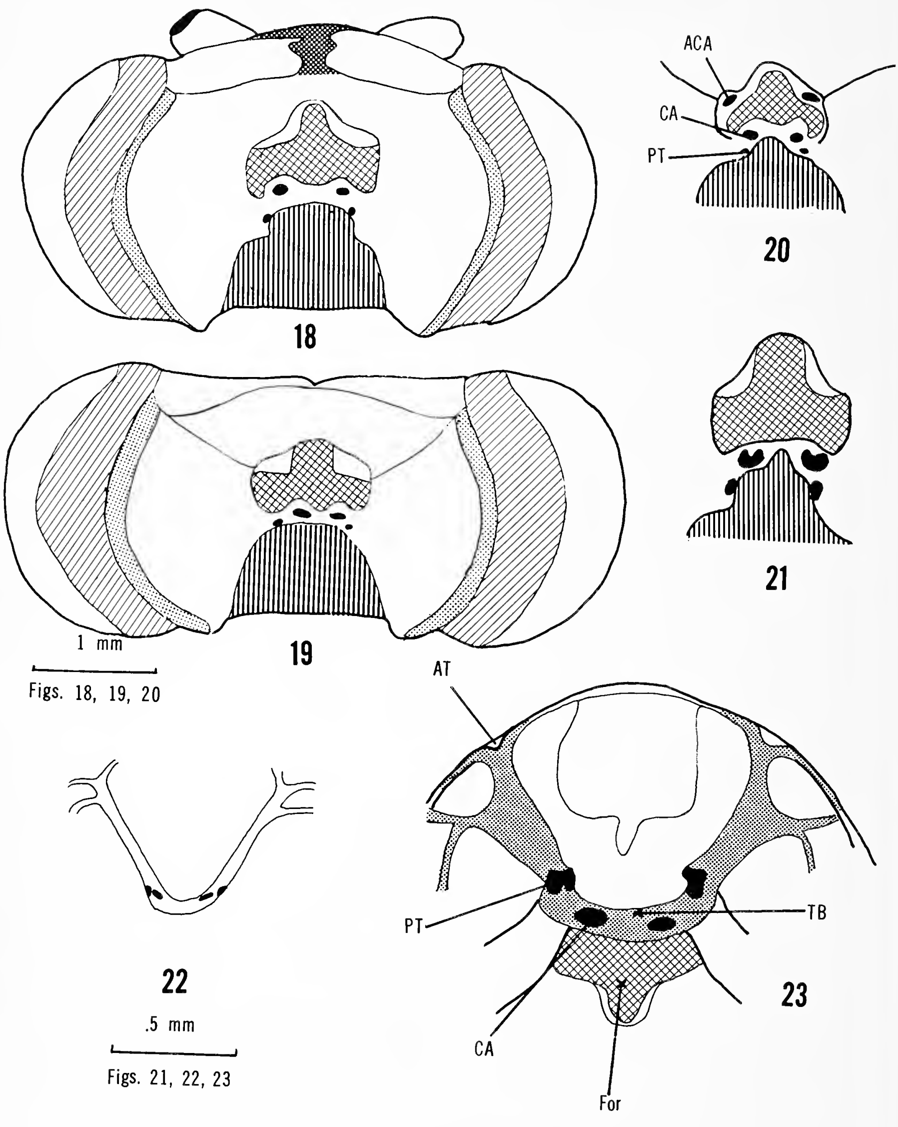


Fig. 18. *Megathymus yuccae,* posterior view. 19. *Mysoria affinis,* posterior view. 20. *Myscelus phoronius,* postocciput and occipital foramen. 21. *Celaenorrhinus proxima,* postocciput and occipital foramen. 22. *Coeliades forestan,* tentorium. 23. *Spathilepia clonius,* tentorium.

capsule to the posterior edges of the antennal sockets. The transfrontal suture separates the vertex from the rest of the hesperioid face. The vertex is delimited also by the epicranial sulcus, which branches anteriorly into two thin transverse sutures (TrS). This condition will be referred to as Type A (fig. 4) An epicranial sulcus of Type A is found in all Trapezitinae and Euschemonidae. The Megathymidae show either Type A or a forked version of Type A (fig. 6). In the Coeliadinae a similar condition to Type A is found, but the transverse sutures branch anteriad into more of a V-shaped structure (fig. 7). In some cases the transverse sulci form a heavily sclerotized, fused, twin-leaf structure (Type C, fig. 8). This modification is well developed particularly in the Pyrrhopyginae.

Both Types A and C, as well as an intermediate condition, are found in the Hesperiinae and Pyrginae. The intermediate condition (Type B, fig. 5) has thin transverse sutures posteriad with a mid-dorsal line. The area between the sutures and the mid-dorsal line is somewhat lightly sclerotized with the sutures and the mid-dorsal line disconnected. Table II lists the various forms of the transverse sutures found in the Hesperiinae and Pyrginae examined.

Three species were exceptional with the transverse suture reduced to a short vertical line and a slight indication of the mid-dorsal line (*C. proxima,* fig. 12, *S. ascaphalus,* fig. 11 and *C. dacela,* fig. 9). The sclerotization associated with the transverse sulci is occasionally ornamented (*Q. cannae,* fig. 13 and *U. dorantes,* figs. 14, 15).

No evidence of the paratemporal sutures prominent in the Papilionoidea was found.

Occiput

The occipital region (Oc) is separated dorsally from the vertex by the transoccipital sutures (TocS; the transoccipital band of Ehrlich, 1960) and from the labial region by a ventral membranous area (fig. 16). The centrally located occipital foramen (For) is bounded on three sides by the postocciput and ventrally by the sclerotized bar supporting the cervical articulations (CA). The general shape of the occipital foramen basically falls into two types: (1) an inverted T-shaped structure (fig. 17), found in all Trapezitinae; and (2) a sub-rectangular structure which is rounded dorsally found in all Megathymidae, Pyrrhopyginae, Coeliadinae, and Euschemonidae. Both general shapes are found in the Pyrginae and the Hesperiinae. The above observations may be only related to size with type 2 characteristic of larger specimens.

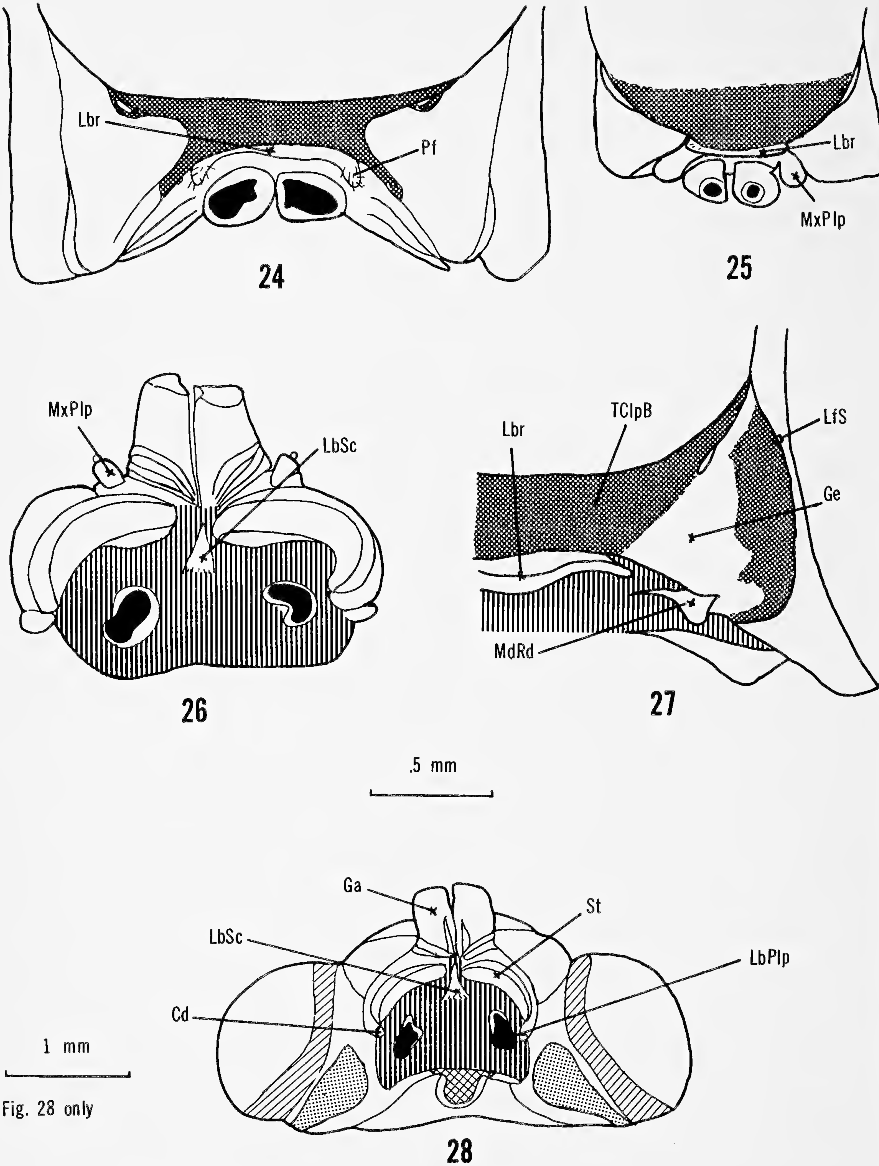


Fig. 24. *Spathilepia clonius,* anterior view (clypeolabral area). 25. *Pyrrochalcia iphis,* anterior view (maxillary palpi). 26. *Agathymus carlsbadensis,* ventral view (maxillary palpi). 27. *Mimoniades minthe,* anterior view (mandibular rudiment). 28. *Megathymus texana,* ventral view.

The postocciput (Poc) is generally obliterated mesad, gradually widens laterally and terminates above the articulations of the cervical sclerites. This structure may appear as a parallel band along the edge of the occipital foramen (fig. 18) or as a well differentiated structure, as in *M. affinis* (fig. 19). Both types and various intergradations between them are found, without any particular relationship to higher categories.

The cervical articulations (CA) lie mesially in the sclerotized bar ventrad of the occipital foramen, except in *C. galenus* and *C. proxima* (fig. 21) in which the bar is sinuate. The posterior tentorial pits (PT) lie ventrolaterally from the cervical articulations.

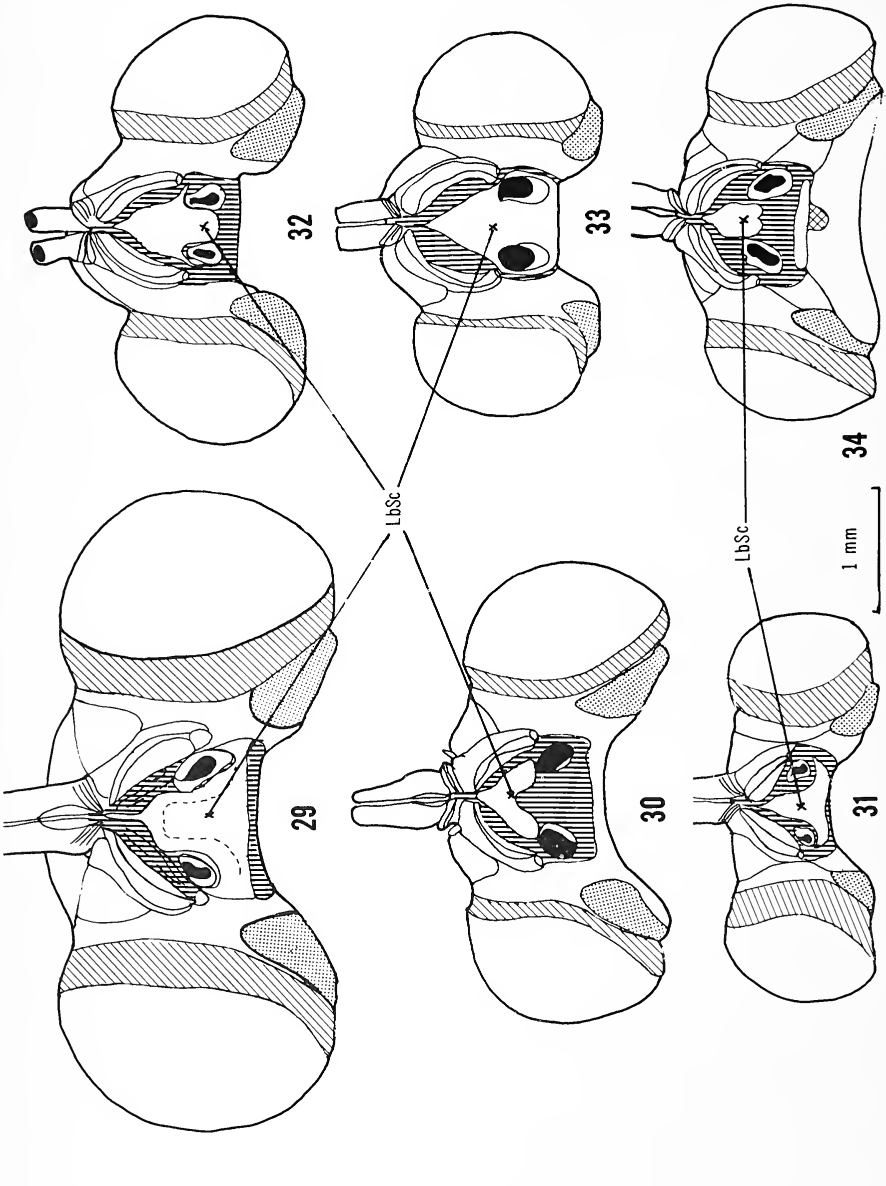
An unusual situation occurs in one of the Pyrrhopyginae studied. Two sets of cervical articulations are found in *M. phoronius* (fig. 20). The auxillary cervical articulations (ACA) are located in the postocciput on either side of the occipital foramen.

Ehrlich (1960) described the occiput as being divided into two regions by the transoccipital suture: an inner darkly sclerotized area and an outer lightly sclerotized one (fig. 16). The lightly sclerotized area also has pronounced hairy sockets and a fine hair fringe covering not only this area, but continuous across the posterior part of the vertex. The exact nature of the lightly sclerotized structures has not been determined, but it was present in all specimens examined.

Mouthparts

The labrum (Lbr) appears as a thin, rectangular, lightly sclerotized bar dorsad of the hypopharnyx (fig. 24). The outer edges of the labrum usually are bent downward into the pilifers (Pf). The pilifers may also be reduced (fig. 25). Chaetae are usually found covering the pilifers but in some cases a fringe of hair may cover the entire outer edge of the labrum.

The literature supporting the existence of maxillary palpi (MxPlp) in the case of the Hesperioidea is rather confusing. Philpott (1927) indicated that such structures are present and are two-segmented. Imms (1964) and Forbes (1923) in describing the superfamily indicate that the maxillary palpi are lacking. Maxillary palpi were evident in this study and were observed in three conditions: (1) a conspicuous raised swelling near the base of the proboscis (fig. 25), (2) two-segmented, and (3) three-segmented palpi (fig. 26). All of the Coeliadinae as well as *A. neumoegeni, Q. cannae, T. flesus, E. clarus* and *M. nurscia* have the conspicuous swelling at the location of the maxillary



Figs. 29-34: different sizes of labial sclerites. 29. *Mysoria affinis*. 30. *Caenides dacela*. 31. *Dalla cypselus evages*. 32. *Celaenorrhinus fritzgaertneri*. 33. *Celaenorrhinus galenus*. 34. *Quinta cannae*.

palpi. Two-segmented palpi were observed in *T. c. argeus*, *C. dacela*, *P. syvicola*, *S. flammeata*, *M. atralba*, *H. chrysotricha*, *S. ascaphalus*, and *E. rafflesia;* whereas *M. texana M. yuccae* (figs. 1 or 41) and *A. carlsbadensis* (fig. 26) have three-segmented maxillary palpi.

Another structure which is ill-defined in the literature is the mandibular rudiment (MdRd). The mandibular rudiments are structures which either articulate or are fused with fronto-clypeus or the paraocular areas (genae, Ge). In one species, *M. minthe* (fig. 27) a sclerite is present in the membranous area on either side below the labrum and is fused with the gena. There is a pronounced enlargement in the genal area particularly in the Pyrrhopyginae and the Euschemonidae. No enlargement was seen in the other groups.

The labium is quite rudimentary. The labial sclerite (LbSc) in the Hesperioidea generally can be divided into two parts: (1) a small triangular sclerite usually surrounded by a membranous area and located centrally between the stipes (St), and (2) sclerotized rings which surround the articulations of the labial palpi (LbPlp). Each of the articulations of the labial palpi is free except in the Megathymidae (fig. 35) and some Coeliadinae (fig. 36), in which the articulations are continuous with the stripes.

Generally the labial sclerite is reduced, but there is much variation in this area, especially in the Pyrginae and Hesperiinae. The labial sclerite is enlarged in such hesperiines as *C. dacela* (fig. 30) and *Q. cannae* (fig. 34) and terminates anteriad of the labial sockets. An additional labial bar, a rudiment of the prementum (Snodgrass, 1935 and Ehrlich, 1958a) occurs posteriad of the labial sockets in *Q. cannae*. In *D. c. evages* (fig. 31) the labial sclerite is enlarged and extends posteriad, curving around the labial sockets.

The pyrgines *C. fritgaertneri* (fig. 32) and *T. flesus* have enlarged labial sclerites which terminate centrally and anteriad of the labial palpi. *C. galenus* (fig. 33) and *M. affinis* (fig. 29) have the largest labial sclerites of the species examined. By contrast, the other African *Celaenorrhinus* (*C. proxima*) examined had a reduced labial sclerite.

The labial palpi are three-segmented. The proximal segment is longer than the distal one, with the second segment the longest of the three. All of the Coeliadinae had porrect palpi, but many of the remaining groups studied had erect palpi.

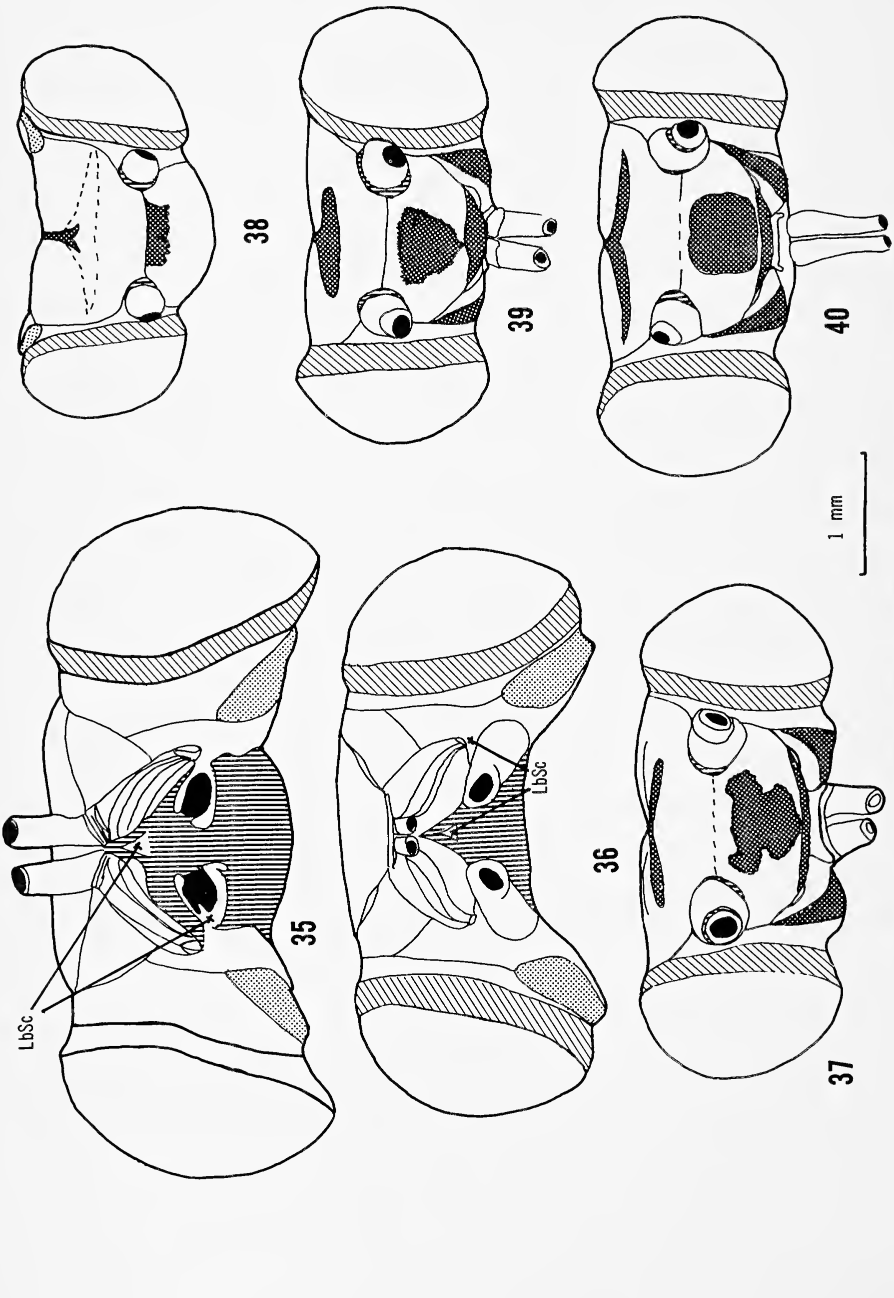


Fig. 35. *Hasora badra*, ventral view. 36. *Megathymus texana*, ventral view. 37. *Spathilepia clonius*, anterior view. 38. *Celaenorrhinus proxima*, dorsal view. 39. *Autochton cincta*, anterior view. 40. *Urbanus dorantes*, anterior view.

Tentorium

The tentorium consists of a posterior tentorial bridge (TB) and two lateral arms which stretch forward from the posterior (PT) to the anterior tentorial pits (AT, fig. 23). The anterior arms generally have well developed wing-like lamellae which taper posteriad toward the tentorial bridge. Sometimes the anterior tentorial arms are not lobate, as in *T. symmomus*, *C. forestan* (fig. 22), *H. chrysotricha*, and *P. a. arizonae*. The lamellae appear to vary with the size of the specimen, *i.e.* the lamellae are well developed in most Megathymidae, Pyrrhopyginae, Coeliadinae, and Euschemonidae. In most of the Pyrginae and Hesperiinae the lamellae are not as well defined.

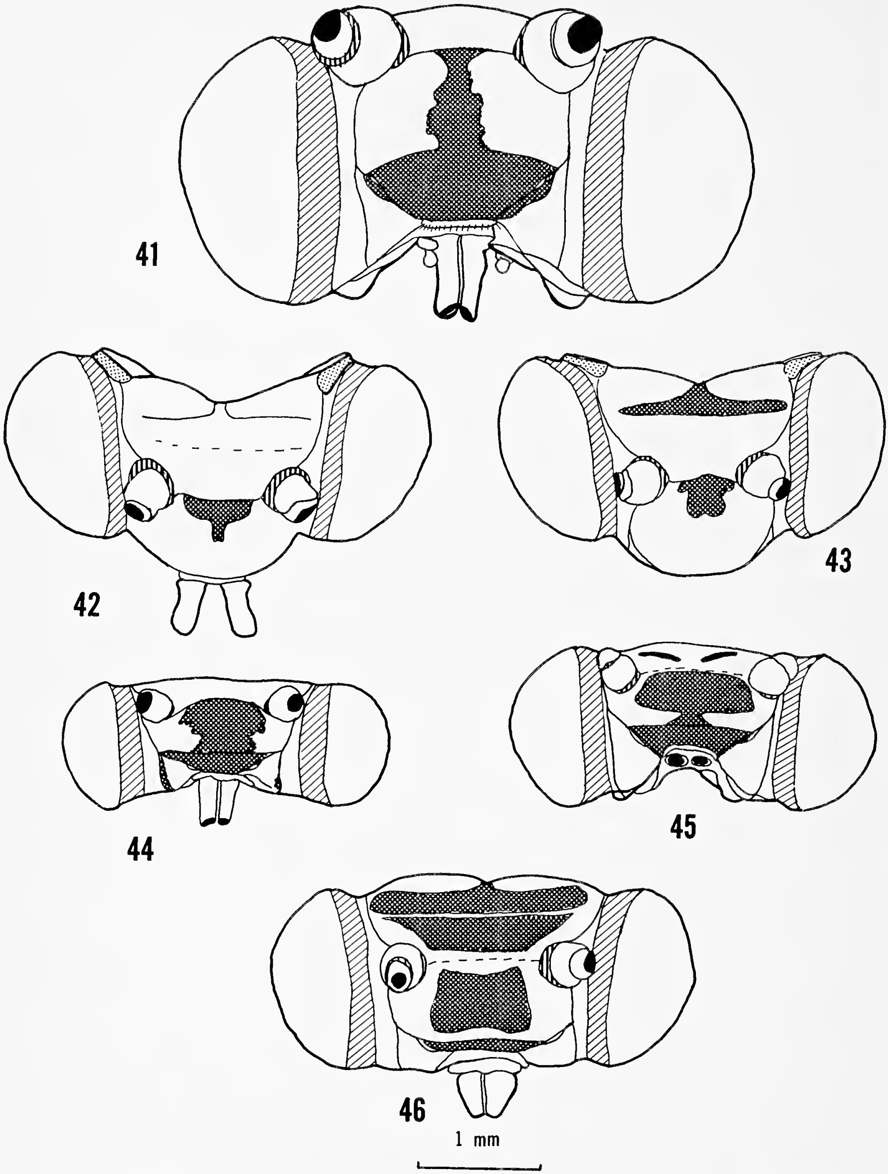
The tentorial bridge is the same sclerotized bar which is observed mesially through the occipital foramen and bears the articulations of the cervical sclerites. The relative distances between these cervical articulations and those of the posterior tentorial pits varies, but no pattern was evident within the respective groups.

A lateral connection at the juncture of the anterior tentorial arm and the anterior tentorial pit with the ocular diaphragm is membranous in most cases or only lightly sclerotized. In the Megathymidae, Pyrrhopyginae and Euschemonidae this lateral connection is heavily sclerotized.

Chaetosema and other ornamentation

Jordan (1923) described the chaetosema as a sensory organ, which is particularly interesting and variable in the Hesperioidea. Most frequently a setiferous patch is found on either side of the occiput at the temporal suture. Other patches may be found, especially in the Hesperiinae and Pyrginae, either in front of the antennae on the face or behind the antennae. An additional patch sometimes occurs in the Pyrginae and Hesperiinae which is centrally located and immediately below the transfrontal suture.

In addition to the chaetosema the hesperioid head is usually covered with numerous ornamental hair tufts. Beneath these hair tufts a difference in the degree of sclerotization is seen. Some of these sclerotic patterns were discussed already under the section concerning the vertex. Additional patterns are evident, particularly around the transfrontal suture and the clypeolabral suture. Such patterns are found in such hesperiines as *D. evages* (fig. 45) and *Q. cannae* (fig. 46), in some studied pyrgines: *U. dorantes* (fig. 40), *A. cincta* (fig. 39), *C. fritzgaertneri* (fig. 42), *S. clonius* (fig. 37), *P. adepta* (fig. 44), *C. proxima* (fig. 38)



Figs. 41-46: sclerotized patterns on the head capsule. 41. *Megathymus yuccae*, anterior view. 42. *Celaenorrhinus fritzgaertneri*, dorsal view. 43. *Celaenorrhinus galenus*, dorsal view. 44. *Pyrgus adepta*, anterior view. 45. *Dalla cypselus evages*, anterior view. 46. *Quinta cannae*, anterior view.

and C. *galenus* (fig. 43), and in *M. yuccae* (Megathymidae; fig. 41). Although there is constant variation from species to species as to the area in which such ornamentation occurs (*P. oileus*, fig. 4 and *P. adepta*, fig. 44), or even if it will occur, there is no variation within a particular species. A number of dissections were done to verify the above in *Pyrgus* and no variation in the location of the ornamentation could be found. Studies are in progress to determine the nature of these patterns which have nothing to do with the phylogenetic organization of the Hesperioidea other than the fact that they occur most frequently in the Hesperiinae and the Pyrginae.

Discussion

Representatives of the three families of Hesperioidea were studied morphologically: Megathymidae, Hesperiidae and Euschemonidae. Structural variation is evident throughout the entire Hesperioidea with structures present or absent with no apparent phylogenetic pattern. Many authorities have divided the Hesperioidea according to the larval feeding habits into two main stocks, the Hesperiinae, monocot feeding, and Pyrginae, dicot feeding, series. Rating the two series, the basic arrangement might be, from primitive to more advanced: (Hesperiinae series): Megathymidae, Trapezitinae, and Hesperiinae; (Pyrginae series): Euschemonidae, Coeliadinae, Pyrginae, and Pyrrhopyginae. Tillyard (1919) regarded *Euschemon* as the most primitive of the superfamily because of the presence of the frenulum.

Forbes (1923) considered the Hesperioidea to be closely aligned to or to have arisen with the Castniidae from the Cossidae. Seitz (1940) believed that the Castniidae were a recently evolved group because of their habits. Castniidae are active particularly in the brightest sunshine, generally visiting white or bright red flowers. The larvae live in stalks, fruits and bulbs of monocots, with many species living in long silk-lined tunnels in or on the ground, reminiscent of the Megathymidae (see also Moss, 1945).

A brief morphological examination made of a few Castniidae showed some definite similarities with the Hesperioidea. The occiput, like that of the hesperioids is divided into lightly and heavily sclerotized areas (fig. 48) in the following Castniids: *Castnia icarus, Castnia licus, Xanthocastnia viryi,* and *Cabirnus linus*. A few other members of the family examined briefly showed the same structural similarities in the occipital area. The transverse sutures of the vertex are reduced to thin lines (see section on vertex, Type A) characteristic of the more primitive

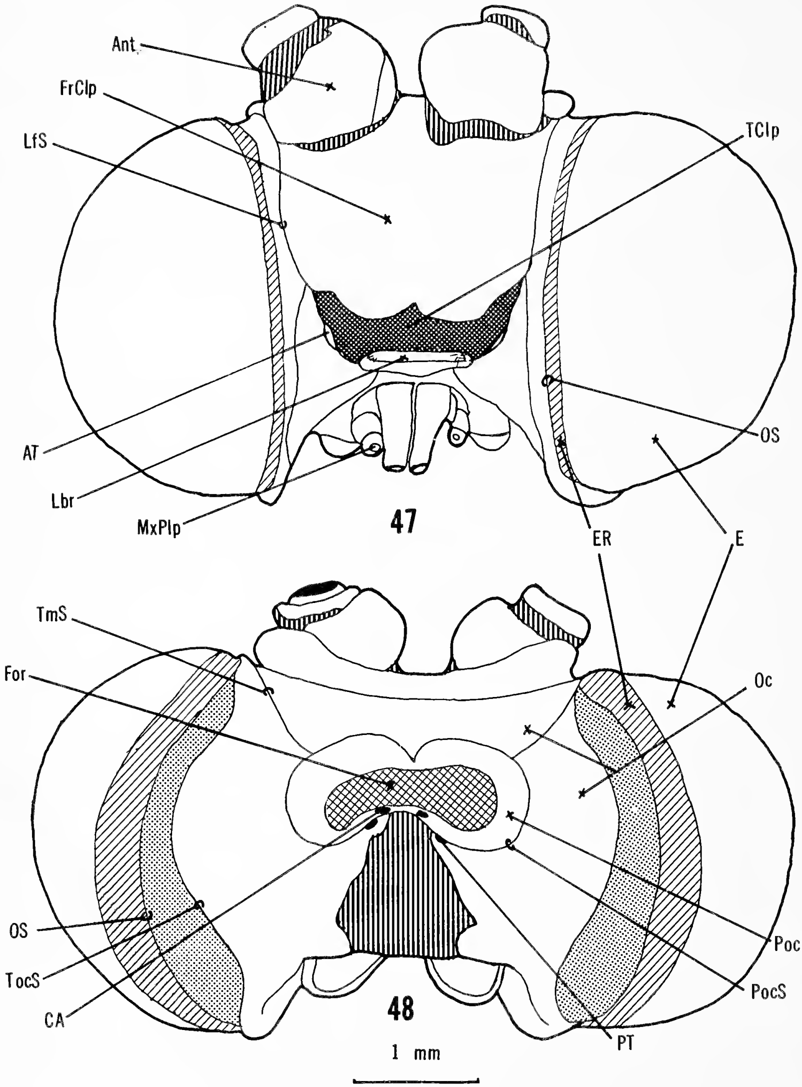


Fig. 47. *Castnia icarus,* anterior view. 48. *Castnia icarus,* posterior view.

skippers. Similarly the shape of the occipital foramen is the same as that of the Megathymidae, Pyrrhopyginae, and Euschemonidae. The labial sclerite is reduced to the triangular sclerite with well developed labial and maxillary palpi. Other structures are not as in the hesperioids. The eyes are entire, but the eye ring is not as well developed anteriorly, with the major portion of the eye ring involuted and heavily sclerotized (fig. 47). The antennae are located very close together, separated, in most cases, by two antennal widths. There is no evidence of the transfrontal suture of the face present in hesperioids or the paratemporal suture of the vertex in the papilionoids. The tentorium is heavily sclerotized and similar to that of *C. forestan* (fig. 22).

The remote possibility of a relationship of the Cossidae and the Hesperioidea was considered, but no striking similarities were noted.

There is some morphological basis for considering the Hesperioidea closely aligned to the Castniidae. Ehrlich (1960) speculated that the entire eye as well as the eye ring separated the Hesperioidea from the Papilionoidea. With the brief examination of a few castniids, the hesperioids appear to be closely related to the castniids, closer than to the papilionids. The lightly sclerotized areas of the occiput, similarities in the shape of the tentorium and the absence of the paratemporal suture of the vertex further separate the Papilionoidea from the Hesperioidea and the Castniidae.

Forbes (1923, p. 43) described the suborder Rhopalocera including the Hesperiidae, as comprised of butterflies with "ocelli and maxillary palpi always absent." The present study as well as that of Philpott (1927) demonstrates that the maxillary palpi are found not only in the Megathymidae and Euschemonidae but also in the Hesperiidae. These maxillary palpi were found in the primitive skippers, and those of different theoretical phyletic lines. This might support the use of the suborder Grypocera for the skippers, but there are some problems with this terminology, too. Originally the attributes of the suborder Grypocera were exaggerated somewhat so that a logical classification of the skippers would be difficult. The old terms Rhopalocera and Heterocera really are used as a matter of convenience and have very little meaning taxonomically. Lindsey, Bell and Williams (1931) probably approached the situation in the most logical way by accepting the division of the Lepidoptera into the suborders Jugate and Frenatae, with the series Rhopalocera further sub-

TABLE I

Condition of the transfrontal suture in various Hesperioidea

Full Suture	Partial Suture	Sulcus
A. neumaegeni	*A. carlsbadensis*	*M. texana*
T. c. argeus	*U. dorantes*	*D. c. evages*
C. dacela	*S. ascaphalus*	*Q. cannae*
P. viator	*T. flesus*	*V. coryna*
T. symmomus	*A. paradisea*	*M. atralba*
H. chrysotricha	*M. affinis*	*P. pigmalion*
S. flammeata	*M. nurscia*	*S. clonius*
E. clarus		*E. zarucco*
A. cincta		*C. forestan*
S. phaselus		*P. iphis*
C. fritzgaertneri		*H. badra*
C. proxima		*B. exclamationis*
C. galenus		*P. a. arizonae*
P. c. adepta		*M. minthe*
P. oileus		
A. baroni		
M. phoronius		
E. rafflesia		

TABLE II

Conditions of the transverse sutures in the Hesperiinae and Pyrginae. The types A, B, and C are discussed in the text.

A	B	C
Hesperiinae	*P. viator*	*Q. cannae*
T. c. argeus	*D. c. evages*	
P. syvicola	*V. c. coryna*	
	C. dacela	
Pyrginae	*E. clarus*	*P. pigmalion*
E. zarucco	*C. fritzgaertneri*	*U. dorantes*
		A. cincta
		S. phaselis
		S. clonius
		C. galenus
		A. paradisea

divided into two superfamilies, Papilionoidea and Hesperioidea, leading to the further subdivision of the latter. However, if one considers the Megathymidae a separate family, there is no logical reason for not considering the Trapezitinae or Coeliadinae separate families.

Obviously a taxonomic classification cannot be entirely based on the hesperioid head, but the results of this study support previous classifications. Further studies of the hesperioid anatomy may provide the basis of a stable yet meaningful classification.

Acknowledgements

Thanks are due to the following individuals and institutions for providing specimens, facilities, and general help and encouragement: Dr. Richard M. Fox, Carnegie Museum, Pittsburgh, Pa., South Australian Museum, Adeliade, Australia, and Mr. A. C. Allyn, Allyn Museum of Entomology, Sarasota, Fla. Special thanks to my husband, Dr. Lee D. Miller, for his patience throughout this entire study and for help in the preparation of this manuscript.

BIBLIOGRAPHY

CROMBACH, G. T., 1967. A comparative study of the exoskeletons of Papilio glaucus L., Eurytide marcellus (Cramer), Battus philenor (L.) and Parnassius phoebus (Fabricius) (Lepidoptera: Papilionidae). Catholic. Univ. America, unpublished M. S. dissertation.

DUPORTE, E. M., 1946. Observations on the morphology of the face of insects. *Jour. Morphol.*, 79: 371-417.

————, 1956. Median facial sclerite in larval and adult Lepidoptera. *Proc. R. Ent. Soc., London,* (A)31: 109-116.

————, 1957. The comparative morphology of the insect head. *Ann. Rev. Ent.*, 2: 55-70.

————, 1959. Manual of insect morphology. New York, N. Y., Reinhold Publ. Co.; 224pp.

EHRLICH, P. R., 1958a. The integumental anatomy of the monarch butterfly Danaus plexippus L., (Lepidoptera: Danaidae). *Univ. Kansas Sci. Bull.*, 38: 1315-1349.

————, 1958b. The comparative morphology, phylogeny, and the higher classification of the butterflies (Lepidoptera: Papilionoidea). *Univ. of Kansas Sci. Bull.,* 39: 305-370.

————, 1960. The integumental anatomy of the silver-spotted skipper. Epargyreus clarus (Cramer) (Lepidoptera: Hesperiidae). *Microent.* 24: 1-23.

EHRLICH, P. R. and A. H. EHRLICH, 1962. The head musculature of the butterflies (Lepidoptera: Papilionidae). *Microent.,* 25: 1-89.

EVANS, W. H., 1937. A catalogue of the African Hesperiidae . . . London, *Trustees British Mus. (Nat. Hist.)*: v-xii + 212pp.

————, 1949. A catalogue of the Hesperiidae of Europe, Asia, and Australia . . . London, *Trustees British Mus. (Nat. Hist.)*: v-xix + 502pp.

————, 1951. A catalogue of the American Hesperiidae . . . Part I. Pyrrhopyginae. London, *Trustees British Mus. (Nat. Hist.)*: vii-x + 92pp.

————, 1952. A catalogue of the American Hesperiidae . . . Part II. Pyrginae. Section I. London, *Trustees British Mus. (Nat. Hist.)*: v + 178pp.

————, 1953. A catalogue of the American Hesperiidae . . . Part III. Pyrginae. Section 2. London, *Trustees British Mus. (Nat. Hist.)*: v + 246pp.

————, 1955. A catalogue of the American Hesperiidae . . . Part IV. Hesperiinae and Megathymidae. London, *Trustees British Mus. (Nat. Hist.)*: v + 499pp.

FORBES, W. T. M., 1923. The Lepidoptera of New York and neighboring states. Part I. Ithaca, N. Y., *Cornell Univ.*: 729pp.

IMMS, A. D, 1964. A general textbook of entomology (ninth edit. revised by O. W. Richards and R. G. Davies). London, Methuen & Co., Ltd.: v-x + 886pp.

JORDAN, K., 1923. On a sensory organ found on the head of many Lepidoptera. *Novit. Zool.* 30: 155-158.

LINDSEY, A. W., Jr., 1931. E. L, Bell and R, C, Williams, Jr., 1931. The Hesperioidea of North America. *Denison Univ. Bull., Jour. Sci. Labs.*, 26: 1-150.

MATSUDA, R., 1965. Morphology and evolution of the insect head. *Mem. American Ent. Inst.*, (4): 1-334.

MOSS, A. M., 1945. The Castnia of Pará with notes on others (Lepidoptera: Castniidae). *Proc. R. Ent. Soc.* (B) 14 Pts. 3-4: 48-52.

PHILPOTT, A., 1927. The maxillae in the Lepidoptera. *Trans. Proc. N. Z. Inst.* 57: 721-746.

SCUDDER, S. H., 1872. A systematic revision of some of the American butterflies with brief notes of those known to occur in Essex County, Mass. *Rept. Peabody Acad. Sci.*, 1871: 24-82.

SEITZ, A., 1940. The Macrolepidoptera of the World. VI. The American Bombyces and Sphinges. Stuttgart, Alfred Kernen Verlag: 1327pp.

TILLYARD, R. J., 1919. On the morphology and systematic position of the family Micropterygidae (sens. lat.). *Proc. Linn. N. S. W*, 44: 95-136,

WATSON, E. Y., 1893. A proposed classification of the Hesperiidae with a revision of the genera. *Proc. Zool. Soc. London*, 1893: 3-132.

ABBREVIATIONS USED IN ILLUSTRATIONS

ACA—auxillary cervical articulations
Ant—antenna
AT—anterior tentorial pits
CA—cervical articulations
Cd—cardo
ClS—clypeolabral suture
E—eye
ER—eye ring
For—occipital foramen
FrClp—frontoclypeus
Ga—galea
Ge—gena
Lbr—labrum
LbPlp—labial palpus
LbSc—labial sclerite
LfS—laterofacial suture
MxPlp—maxillary palpi
MdRd—mandibular rudiment
Oc—occiput
OS—Ocular suture
Pf—pilifer
Poc—postocciput
PocS—postoccipital suture
Prb—proboscis
PT—posterior tentorial pits
TB—tentorial bridge
TClpB—transclypeal band
TfrS—transfrontal suture
TmS—temporal suture
TocS—transoccipital suture
TrS—transverse suture

Journal of Research on the Lepidoptera 9(4):215-216, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A NEW *PARNASSIUS EVERSMANNI* RACE FROM NORD-EAST SIBERIA (USSR) PAPILIONIDAE

DALIBOR WEISS

Bruselská 3, Praha 2, Vinobrady, Czechoslovakia

In the autumn of the year 1969 I received a parcel with fresh specimens of the various holarctic species of the group Rhopalocera from USSR. These specimens were captured in the Magadan Region in the northeastern part of the Kolimskii Ridge near the Tauj Bay at the northern coast of the Ochotsk Sea.

Besides specimens of *Erebia discoidalis* Kirby, *Erebia embla dissimulata* Wrn., *Clossiana freija* Thnb. and some other species of Rhopalocera, a series of very interesting specimens of *Parnassius eversmanni Mén.* were included in that parcel. These specimens were collected near the Kegali River in the region situated between Kongii and Uschurakcchan Mountains near 64° North approximately 50 km from the Omolon settlement.

The specimens of *P. eversmanni* morphologically and habitually belong to the group of nominate race and belong next to the ssp. *thor* Edw., so that they present the interstage between the two named subspecies.

Form of the wings is rather broad, apex of the forewings is rounded. The ground color of the wings in males is pale lemon-yellow, the inner black pattern of the forewings are fine and thin, more contrast and less transparent than in ssp. *thor,* but sharply lineated with no indication of diffusion. The glass-band is relatively narrow with almost straight inner bounds not so undulate like often in ssp. *thor.* The submarginal band relatively narrow, very sharply lineated reaching up to the Cu_2 like in ssp. *thor.* The median-band is also narrow, distinctive and in the middle narrow. The discal-spot is relatively slender but the middle discoidal spot is distinctive, broad and is connected below, in contradistinction to the ssp. *thor* and the nominate race, with the base of the wings by the broad black band. The base of the forewings is relatively pale, scantly covered with scales. The black band of the back-margin and the anal-spot of the hindwings are clean cut like in the nominate race and ssp. *thor,*

submarginal band is almost dissolved like in the ssp. altaica Vrty. The red spots on the hindwings are similar like in ssp. *thor.* They are smallish with broad black borders, the subcostal red spots are larger and more deeply colored than the eye-spots. The latter are sometimes reduced to smaller black spots in even smaller red center.

The ground color of the female is clear white with contrasting black patterns like in the nominate race and ssp. *thor,* but the patterns are more narrow, sharply differentiated from the neighboring white parts. The length of the forewing in males is 28-30 mm; in females 28 mm.

Because of the locality and the distinct morphological characters of these specimens, I take them to be representatives of a new geographical race with the name:

Parnassius eversmanni magadana ssp. n.

Holotype ♂ (Fig. 1): USSR, Siberia sept. or., Magadansk, Kolimskii Ridge, Kegali River, 1,000m 21.VI.1969 (in coll. Mus. Pragense).

Allotype ♀ (Fig. 2): Same data as holotype (in coll. mea).

Paratypes 10 ♂ ♂ : Same data (7 sp. in coll. mea, 2 sp. in coll. A. Hübner, Vienenburg-Harz, BRD, 1 sp. in coll. J. Smelhaus, Praha).

List of the named geographical races of *Parnassius eversmanni* Mén.:

ssp. *eversmanni* Ménétriés 1849, Siemaschko, Russk. Faun. 4 — USSR, Sajan Mt., Irkutsk, Krasnojarsk.

ssp. *altaicus* Verity 1899, P. Elwes in: Tr. ent. Soc. London 314, 299 — USSR, Altai Mt., Tschuja

ssp. *wosnesenskii* Ménétriés 1849, Siemaschko, Russk. Faun. 4 — USSR, Siberia sept. or., Ochotsk

ssp. *litoreus* H. Stichel 1888, Graeser in: Berlin. ent. Z. 32, 65 — USSR, Amur, Nikolajevsk

ssp. *maui* Bryk 1911, O. Staudinger et A. Bang-Haas (i. l.) Lep. Liste. 55, 4 — USSR, Ussuri, Wladivostok, Sichote Alin

ssp. *innae* Kotshubej 1929, Ent. Anz. 9, 190 — USSR, Polovina, Bureia River

ssp. *daisetsuzana* Matsumura 1926, Ins. Mutsum. 1, 103 — Japan sept. Hokkaido

ssp. *thor* W. H. Edwards 1869, P. Scuder in: P. Boston, Soc. 12, 407 — U.S.A. Alaska, Yukon River, Keno Hill

ssp. *sasai* O. Bang-Hass 1938, Matsumura S, Insect. Matsum. 11, 132 B. F. Bryk in: Parnassiana 5, 41 — Corea sept. Prov. Chazu, Yrin River, Koya Mt.

Figure 1 (top) and 2 (bottom) on cover.

Journal of Research on the Lepidoptera 9(4):217-222, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A NEW SUBSPECIES OF *LIMENITIS ARCHIPPUS* (NYMPHALIDAE)

PETER J. HERLAN
Curator, Dept. of Biology, Nevada State Museum
Carson City, Nevada

Limenitis archippus lahontani **Herlan, New subspecies**

Holotype male: Nevada, Lyon Co., Fernley. Sept. 6, 1966 (D. L. Bauer); Allotype female: Nevada, Lyon Co., Farm District Rd., Fernley. July 26, 1966 (D. L. Bauer). The type locality of *lahontani* is hereby restricted to Fernley, Lyon Co., Nevada, Holotype male and Allotype female deposited at the Los Angeles Co. Museum.

DESCRIPTION: HOLOTYPE MALE

Expanse 63 m.m. Paratype males 60.66 m.m.

Superior Surface

The ground color of primaries and secondaries much paler than the nominotypic subspecies of *L. archippus* (Cramer).

Primaries:

The ground color light ochraceous; shading to a darker tone near the costal margin. The black sub-apical triangle based on the costal margin of *archippus* and reaching the outer margin near Cu2 is based post-median on the costal margin of *lahontani;* reduced in size and intensity and never extending to the outer margin.

Secondaries:

Ground color similar to the primaries. The smudged dark overscaling along the anal margin of *archippus* is a light buff tone on *lahontani*. The solid black transverse post-mesial band found on *archippus* is broken into a series of discrete black dashes, disconnected at the nervules on *lahontani*.

Inferior Surface

Primaries:

The ground color of the discal area similar to the superior surface. The costal patch intense black and extending to the outer margin as in *archippus*. The apical and sub-apical area buff with overtones of ochre.

Secondaries:

The ground color lighter than the primaries; a uniform light buff with dashes of ochre between the nervules in the post limbal area. The mesial band unbroken and slightly swollen at the nervules.

ALLOTYPE FEMALE:

Expanse 68 m.m. Paratype Females 67.75 m.m.

Similar in color and pattern to the holotype male.

RANGE: NEVADA-UTAH

Nevada: At present known only from two closely related areas extending from west-central to northeastern Nevada. Area one follows the course of the Humboldt River from Elko to Lovelock. Nowhere along the river or the adjacent canal systems is it common. It has been taken in limited numbers at Elko, Winnemucca, Rye Patch Dam, and Lovelock. Area two follows the route of the Truckee Canal System from Wadsworth and Fernley to the Lahontan Dam thence along the Lahontan Canal System to the Fallon Area.

Utah: At present known only from the vicinity of Salt Lake City, Ogden, and Provo.

GENERAL DISCUSSION

Nowhere in its present range is *lahontani* abundant. Its existence is being continually threatened by the use of herbicides and the practice of burning *Salix* sp. along the canals and ditch banks.

The center of population is around Fernley, Nevada. For this reason it has been designated the type locality although it is far south and west of the center of distribution.

It seems reasonable to assume that during the early Neo-Thermal stages of the Lahontan and Bonneville Lake Systems *lahontani* enjoyed a much wider distribution than today. Lake Lahontan covered much of the area between Fernley and Lovelock at that time and undoubtedly there was a sufficient growth of *Salix* sp. along the shore line to support a series of colonies through the present Carson and Humboldt sinks. These barren deserts very effectively separate the Humboldt and Truckee colonies today.

Collecting in the area north and east of Elko towards the Snake River system in Idaho has so far failed to turn up additional specimens. However the possibility of locating *lahontani* there should not be ruled out for the future.

A long series of specimens collected by D. L. Bauer in Morrow Co., northeastern Oregon and the adjacent Columbia River area indicate the presence there of an unnamed race intermediate to *archippus* and *lahontoni.*

Thirty-eight specimens examined from the Salt Lake City, Ogden and Provo areas were identical in all respects to those from Nevada. This was to be expected as during the early Neo-Thermal the Lahontan and Bonneville Lake Systems were contiguous along the present Nevada-Utah border. Material examined from Uintah and Grand Co. of eastern Utah is referable to *archippus* as it is known from Colorado to the eastern seaboard.

There is no evidence at hand of a contact or blend zone between *a. lahontani* and *a. obsoleta* from southern Nevada. The absence of *Salix* sp. from the deserts south and east of Fallon plus the distances involved very effectively rule out any mingling of these two races.

The colonies of *lahontani* are found at lower elevations along the permanent water courses of the Lahontan and Bonneville Basins.

It is closely associated throughout its range with *Salix exigua.* Nutt. the common willow of the Great Basin. Although other *Salix* sp. are present, in its range, *lahontani* has not been found where *exigua* is absent. Additional research will be necessary to establish the true relationship of *lahontani* and S. *exigua.* Females have been observed ovipositing on *exigua.* The problem of whether or not, under natural conditions, *exigua* is the preferred host plant of *lahontani* to the extent that it rejects other available *Salix* sp. has yet to be resolved. This could be the factor that limits its altitudinal range to the valleys below 6000′. I know of no specimens from higher mountain elevations.

PARATYPE SERIES

CHURCHILL CO.: Fallon, 7-VIII-66 2♂ 1♀. ELKO CO.: Elko, 27-VIII-66 1♂. HUMBOLDT CO.: Winnemucca 26-VIII-66 1♂. LYON CO.: ½ mi. E. Fernley 14-VIII-66 1♂. 10 mi. E. Fernley 14-VIII-66 6♂ 3♀. 7½ mi.E. Fernley 27-VII-66 1♀. 29-VII-66 3♀. 3-VIII-66 1♀. 6-VIII-66 3♂ 1♀. 7-VIII-66 2♂ 1♀. 5 mi. E. Fernley 28-VII-66 2♂. 3-VIII-66 3♂. 6-VIII-66 4♂. PERSHING CO.: Lovelock 15-VII-66 1♀. Rye Patch Dam 25-

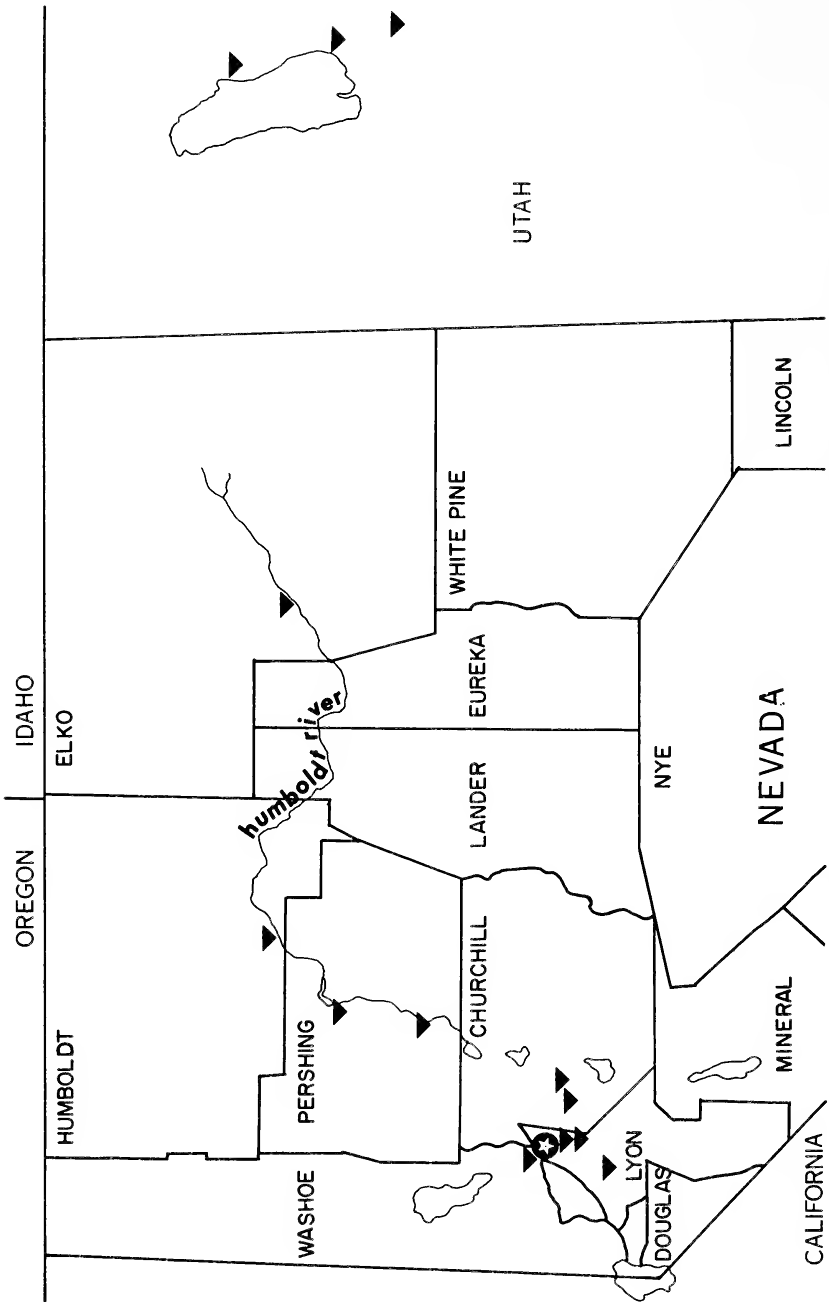


Fig. 1. Geographic distribution of *Limenitis archippus lahontani* in Nevada and Utah. *Type locality.

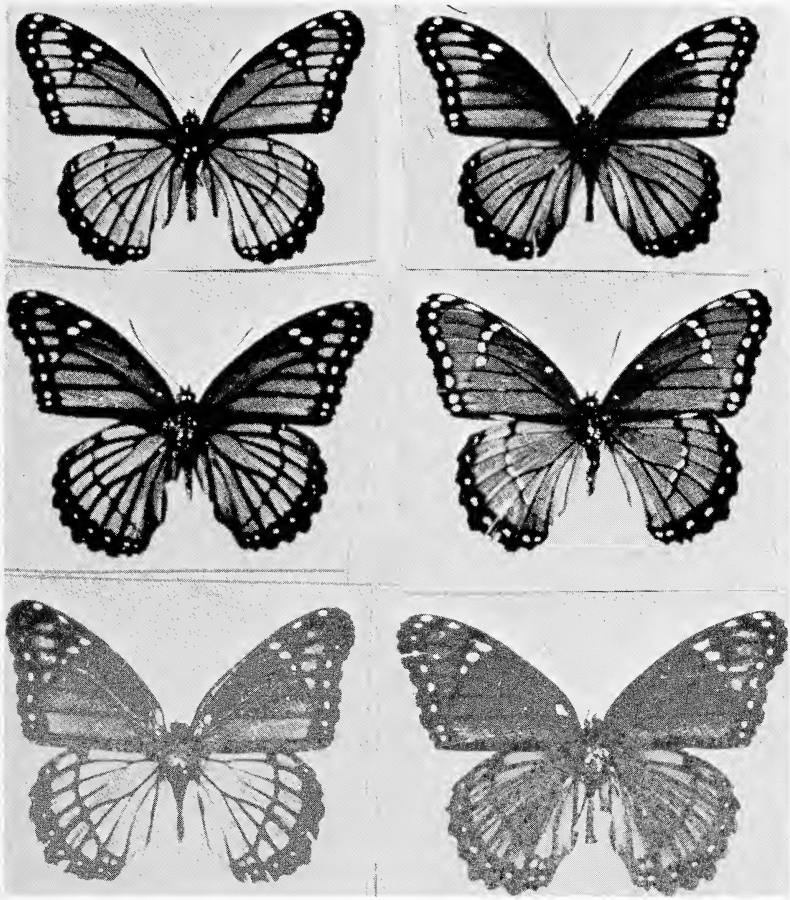


Fig. 2

Top left: *L. lahontani* 6-IX-66, Fernley, Nevada; top right: *L. hoffmanni* 29-VII-54, Tomaseno, Tamalpais, Mexico; middle left: *L. archippus* 1-VIII-67, Sharon, Ohio; middle right: *L. obsoleta* 4-X-64, Overton, Nevada; lower left: *L. watsoni* 12-X-38, Bayou Sorrel, Louisiana; lower right: *L. floridensis* 15-VII-57, Sanford, Florida.

Color photos, including types, to appear in subsequent issue.

VIII-66 1♀. WASHOE CO.: 2 mi. N. Wadsworth 11-VIII-66 3♂. (all P.J.H.) Deposited in Nevada State Museum Collection. LYON CO.: West Side Fernley 4-VIII-66 3♂. 16-VIII-66 3♂ 1♀. 6-IX-66 1♀. 8-IX-66 1♂ 1♀. 5 mi. E. Fernley U.S. Alt. 95. 28-VII-66 3♂. Farm District Rd. Fernley 28-VII-66 1♂ 1♀. Farm District Rd. 8 mi. E. Fernley 28-VII-66 1♂ 1♀. WASHOE CO.: Truckee River, Wadsworth 16-VIII-66 2♂. (all D. L. Bauer) Collection D. L. Bauer.

ACKNOWLEDGEMENTS

I wish to acknowledge the helpful cooperation of the following for making available specimens for examination and data from private and institutional collections in their care: Dr. Paul Arnaud, Jr., California Academy of Sciences, San Francisco; D. L. Bauer, South Tahoe, California; Thomas W. Davies, San Leandro, California; L. M. Martin, Los Angeles County Museum, Los Angeles; Kenneth Tidwell, Salt Lake City, Utah. I would also like to express my appreciation to: Howard Hickson, Nevada State Museum (Distribution Map); D. J. Gray, Nevada State Museum (Photos).

BIBLIOGRAPHY

BROWN, F. M., 1957. *Colorado Butterflies.* 367 pp. Denver Museum of Natural History.

EHRICH, P. R. and EHRLICH, A. H., 1961. *How to Know the Butterflies.* 262 pp. Wm. C. Brown.

HOLLAND, W. J., 1931. *The Butterfly Book.* 424 pp. 77 plates, Doubleday Co.

KLOTZ, A. B. *A Field Guide to the Butterflies.* 349 pp. Houghton Mifflin Co.

MUNZ, PHILIP A., 1963. *A California Flora.* 1681 pp. University of California Press.

Journal of Research on the Lepidoptera 9(4):223-226, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

ON THE OCCURRENCE OF *LIMENITIS ARCHIPPUS* X *L. LORQUINI* HYBRIDS (NYMPHALIDAE)

EDWIN M. PERKINS, JR.[1]

and

EDWARD V. GAGE[2]

IN JULY, 1965, AN UNUSUAL EXAMPLE of *Limenitis ssp.* was captured by E. V. Gage along the Amon wasteway, approximately 2 mi. S. of the Richland Y (confluence of Columbia and Snake Rivers), in Benton County, Washington (figs. 1, 2). Not until four years later, with J. C. Montgomery's discovery of 3 additional males—again taken along the Amon wasteway—did the identity of the presumably aberrant, original specimen become more focused.

A search through the literature revealed that these 4 *Limenitis* examples closely resembled the eastern *L. arthemis* (Drury) x *L. archippus* (Cramer) hybrids that were described and designated *arthechippus* by Scudder (1889), and later illustrated by Field (1914). More recently, a comparable hybrid from New York has been recorded and figured by Shapiro and Biggs (1970).

Given that 1) records of *L. weidemeyerii latifascia* (Perkins and Perkins, 1967) exist neither from the state of Washington nor from that region of Oregon contiguous to same; 2) *L. lorquini burrisonii* form norm. *maynardi* (Field), 1936 (figs. 1, 2) and its infrequently occurring, red-spotted form (*L. l. burrisonii* Maynard, 1891) do reside commonly in this area (Perkins and Perkins, 1966); and 3) the somewhat local, less frequently encountered Great Basin race of *L. archippus* (figs. 1, 2)—described and designated *lahotani* (Herlan, 1971)—is sympatric with *L. lorquini* in this same region, it is probable that the 4

[1]*Department of Biological Sciences, Allan Hancock Foundation, Room 103, University of Southern California, University Park, Los Angeles, Ca. 90007*
[2]*Route 1, P. O. Box 10, Richland, Washington 99352*

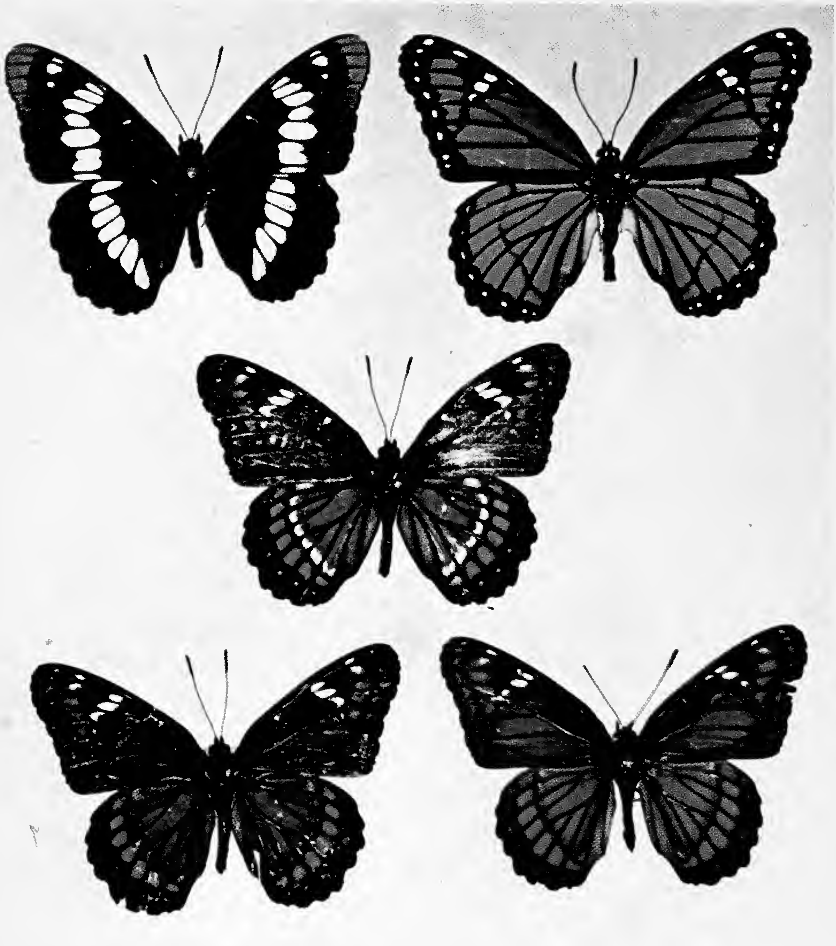


Fig. 1.—*Limenitis* from vic. Richland, Benton Co., Washington. Upper surfaces. Top left: *L. lorquini burrisonii* form norm. *maynardi* ♂, 31.V.70 (EVG). Top right: *L. archippus lahotani* ♂, 9.VII.70 (EVG). Center: *L. archippus* x *lorquini* ♂, 6.VII.69 (JCM). Lower left: *L. archippus* x *lorquini* ♂, 4.VII.65 (EVG). Lower right: *L. archippus* x *lorquini* ♂, 6.VII.69 (JCM).

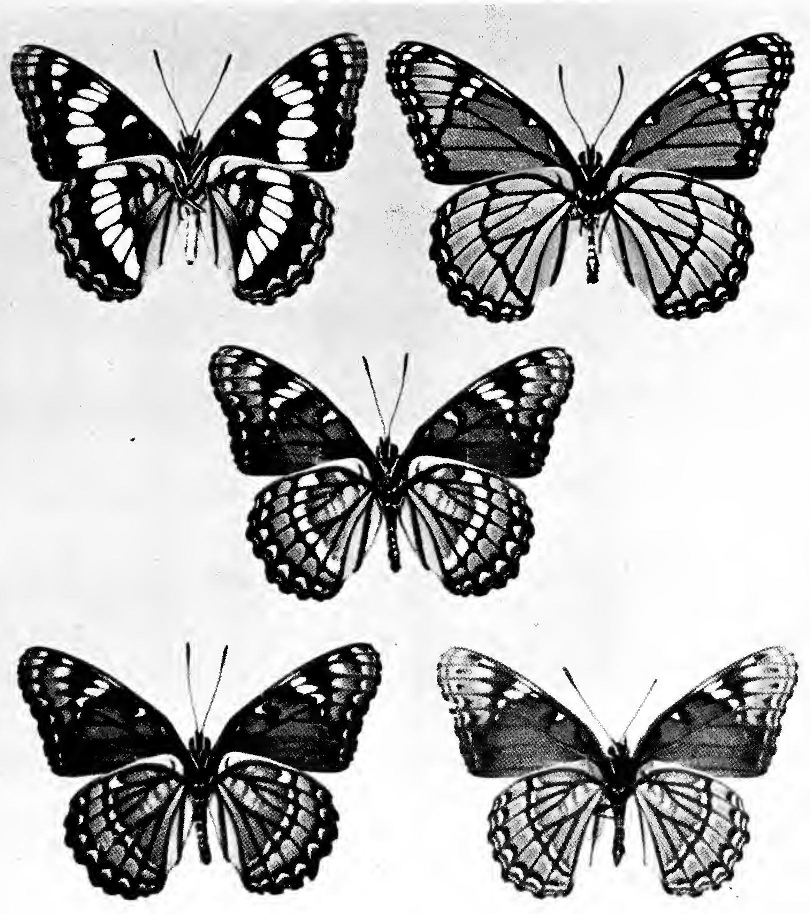


Fig. 2.—Lower surfaces of the specimens illustrated in Fig. 1.

hybrid males represent the F_1 of an *archippus-lorquini* cross.

Although somewhat variable, it is interesting that each of the western *archippus* x *lorquini* hybrids closely resembles the eastern *archippus* x *arthemis* (=*arthechippus*) hybrid depicted by Shapiro and Biggs. Comparison should be made between the specimens illustrated in this text with those presented by Shapiro and Biggs (1968).

The phenotypic variability of the 4 western, F_1 hybrids suggests considerable elasticity in the P_1 genome; i.e., the variation in markings and ground color manifested by the *archippus* x *lorquini* examples suggests the incompleteness of parental homozygosity for different alleles. As Hovanitz (1949) pointed out: "It seems likely that enough interbreeding occurs between different [*Limenitis*] species so that none of them is able to reach a state of complete homozygosis for the genes by which they differ. Thus hybrids are never all alike."

LITERATURE CITED

FIELD, W. L., 1914. Hybrid buterflies of the genus *Basilarchia*. *Psyche*, 21: 115-117.

GAGE, E. V., 1970. A record of a naturally occuring *Limenitis* hybrid (Nymphalidae). *Jour. Lepid. Soc.*, 24(4): 270.

HERLAN, P. J., 1971. A new subspecies of *Limenitis achippus* (Nymphalidae). *Jour. Res. Lepid., in press.*

HOVANITZ, W., 1949. Increased variability in populations following natural hybridization. In: *Genetics, Paleontology, and Evolution.* (Ed. by Jepsen, G. L., E. Mayr, and G. G. Simpson). Princeton Univ. Press, pp. 339-355.

PERKINS, E. M., and S. F. PERKINS, 1966. A review of the *Limenitis lorguini* complex (Nymphalidae). *Jour. Lepid. Soc.*, 20(3): 172-176.

PERKINS, S. F., and E. M. PERKINS, 1967. Revision of the *Limenitis weidemeyerii* complex, with description of a new subspecies (Nymphalidae). *Jour. Lepid. Soc.*, 21(4): 213-234.

SCUDDER, S. H., 1889. *Butterflies of the Eastern United States and Canada.* Vol. 1, p. 296. Author, Cambridge, Mass.

SHAPIRO, A. M., and J. D. BIGGS, 1968. A hybrid *Limenitis* from New York. *Jour. Res. Lepid.*, 7(3): 149-152.

Journal of Research on the Lepidoptera 9(4):227-232, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

CONCERNING *COLIAS CHRISTINA MAYI* CHERMOCK & CHERMOCK

JOHN H. MASTERS[1]

Lemon Street North, North Hudson, Wisconsin 54016

THE NAME *Colias christina mayi,* as proposed by Chermock & Chermock (1940) to a butterfly from Riding Mountain, Manitoba, has created quite a bit of confusion over its correct application. Most Manitoba lepidopterists apply the name *"mayi"* to their local populations of *Colias christina* Edwards, but elsewhere it is frequently treated as a subspecies of *Colias gigantea* Strecker or *Colias scudderii* Reakirt. Dos Passos (1964) treats it as a synonym of *Colias gigantea harroweri* Klots.

The rather brief and inadequate original description, which I quote below in its entirety, is of little use in solving the problem:

> "*Colias christina mayi* new race"
>
> "This subspecies in color and marking is very similar to *gigantea* (Stkr.) on the upper surface in both sexes; however, it may be readily separated from its nearest relative *gigantea* by the absence of the heavy overcast of black scales on the secondaries and the costal area of the primaries. There is in *mayi* a very sparse sprinkling of black scales on the area just mentioned. The pink fringes are less intense in *mayi* than in *gigantea.* The marginal band of the female varies from a fairly well defined band on the primaries to the total absence of a band." Holotype—male, July 1, 1933, Riding Mountains, Manitoba. Allotype—female, July 1, 1936, same locality. Paratypes—1 to 150, same locality. This race is very abundant in the Riding Mountains."

Six species of *Colias, christina, gigantea, interior* Scudder, palaeno (Linnaeus), *eurytheme* Boisduval, and *philodice* Godart, occur on Riding Mountain and the original description of *mayi* could be construed to fit any of the first four of these. The agreement fits best with *gigantea,* however, and I have ascertained by examination of the holotype female (fig. 1A) and a series of paratypes of both sexes in the Carnegie Museum collection, that the type series of *mayi* represents a population of *Colias gigantea* and not *Colias christina.*

[1]Research Associate, Carnegie Museum, Pittsburgh, Pennsylvania.

At the time of their original description, the Chermock's must have considered *mayi* and *gigantea* both as subspecific populations of *Colias christina;* there is no other logical reason why they would describe their butterfly under *christina* while comparing it to *gigantea*. An interesting note was found attached to a specimen of Riding Mountain *gigantea* in the Barnes collection (now in the U.S. National Museum, Washington), it reads: "Vi-28-1933. I think this *Eurymus* is new. What do you think? F. H. Chermock." Note: *Eurymus* Horsfield is a junior objective synonym of *Colias* Fabricius; it would be the valid name if the I.C.Z.N. had not used its plenary powers to preserve *Colias* by designating *Papilio hyale* Linnaeus as the type species of *Colias*.

A secondary problem in the treatment of *mayi* is a result of it having been preceeded in publication, by a few months, by the description of *Colias gigantea harroweri* Klots (1940). *Harroweri* was described from Sublette County, Wyoming and only Wyoming specimens were included in the type series, but Klots stated: "The name *harroweri* should be certainly applied to Wyoming, Idaho and Montana specimens of *gigantea;* and it should probably also be used for those from the southern regions of Manitoba, Alberta and British Columbia." This is undoubtedly dos Passos authority for sinking *mayi* as a synonym of *harroweri*. However, Klots went on to say: "The southern Canadian specimens are not typical, however, showing in some respects intergradations to *g. gigantea*, and in other respects intergrading to *christina, emilia, alexandra* and *occidentalis* in a very puzzling way." Klots has later said (personal communication, 21 October 1967): "Of course *mayi* Ch. & Ch. has nothing to do with *harroweri*."

To determine if *mayi* is sufficiently distinct from nominate *gigantea* and *harroweri* to stand as a subspecies in its own right, I assembled and compared long series of "*mayi*" from Riding Mountain and "*gigantea*" from Churchill, Manitoba (type locality) with a short series of *harroweri* from the Wind River Range, Wyoming and Polaris, Montana. The Riding Mountain series appears to be, in phenotype expression, much closer to the Rocky Mountain series, but there are a couple of obvious distinctions. Outwardly, it is most distinct from the Churchill series, but the species occurs continuously from Churchill southwestward to The Pas, Manitoba and then southward, along the Manitoba Escarpment, to Riding Mountain, and an examination of short series from intermediate points (e.g. Duck Mountain, The

Pas and Gillam) shows gradual intergradation of characters, indicating that the two populations represent ends of a cline. There has been considerable discussion in recent years as to whether clinal populations should be designated as subspecies, and a persuasive argument can be made for either side of the question. In cases like this where the subspecific names apply at the ends of the cline and where the phenotypical expression at the opposite ends is markedly different, my personal prejudice is to let them stand. Thus I regard *mayi* as a valid subspecies of *Colias gigantea*, representing the Manitoba Escarpment population.

The distinctions between the three subspecies of *Colias gigantea*, as observed in my examination, are summarized below:

(1) Size. *Mayi* is very large compared to the others and *harroweri* averages slightly smaller than *gigantea*. I measured the average fore-wing lengths as:

	males	*females*
C. g. gigantea (Churchill)	26 mm.	27 mm.
C. g. harroweri (Wyoming & Montana)	25 mm.	26 mm.
C. g. mayi (Riding Mountain)	29 mm.	30 mm.

(2) The fuscous dusting on the underside of the hind-wings of both sexes is very dark in *gigantea* and much sparser in both *mayi* and *harroweri*. This is the outstanding phenotypic difference and will prevent *mayi* or *harroweri* from keying out to *gigantea* with Klots' key (1961, couplet 4a-4b).

(3) The black borders on the upper sides of the wings of the males are wider in *harroweri* than either of the others and are slightly wider in *mayi* than in *gigantea*.

(4) Yellow females of *harroweri* are a brighter, warmer yellow than those of *mayi*, while those of *gigantea* are quite pale.

(5) The pink wing fringes are of a more intense color in *gigantea* than in the other two. This is especially noticeable in females.

(6) The ratio of white to yellow females is quite different; almost 100% white in *gigantea*, approximately 50-50 in *mayi* and nearly all yellow in *harroweri*. Hovanitz (1950a) recorded 90.91% white at Churchill, 40% in southern Manitoba (Riding Mountain) and 60% in northwest Wyoming. Hovanitz only examined five females from Yellowstone and I believe his statistical error is quite high, from what I have seen the percentage of white females in the Wyoming population appears to be less than 20%.

(7) The black borders of the fore-wings of females may offer statistical differences. Clifford Ferris (personal communication)

states that he can separate *harroweri* females from *mayi* females by this character; but I don't know how since in my series of *mayi* there is every conceivable combination represented from immaculate wings to borders as complete as in *Colias eurytheme* females. The females of *gigantea* have, on the average, more reduced borders than the others and about 50% of them are immaculate. The females of *mayi* are about 25% immaculate and possibly average a greater reduction of black in the borders than does *harroweri.* My sample of *harroweri* includes only four females and is inadequate for drawing any conclusions in this area.

(8) Klots (1940) states that the color of the apex of the underside of the fore-wing and the entire underside of the hind-wing of the males shows differences between *harroweri* and *gigantea* and that in *harroweri* these areas are of a greenish yellow which does not contrast strongly with the ground-color of the rest of the fore-wing, while in *gigantea* the areas are richer and somewhat orange-yellow which contrasts with the paler hues on the rest of the wing. However, I find the greener cast in *gigantea* and the warmer orange-yellow coloration in *harroweri.*

The description of *Colias christina mayi* was accompanied by a description of *Colias christina mayi* form *marjorie* Chermock & Chermock. This being nothing but the white female of the Riding Mountain population (figure 2). *Marjorie* is an infraspecific name with no standing under The Code (International Code of Zoological Nomenclature). If it is necessary to designate the white females, in an infraspecific sense, "marjorie" is available; however, I feel that it is preferable to use the name "alba" as a *nomen collectivum* for the white females of all dimorphic *Colias* species.

In this paper I have treated *Colias gigantea* as a specifically distinct species from *Colias scudderii;* I have done so for simplicity and convenience in my treatment and not to go on record in the debate over this issue. Hovanitz (1950) consolidated them under *gigantea* and dos Passos (1964) under *scudderi.* Klots (1940, 1951, 1961) and others have steadfastly maintained that they are separate species. *Colias gigantea* (including *mayi* and *harroweri*) is a willow feeder and apparently a bog obligate. It occurs in the true arctic and southward in bogs to Wyoming, Southern Manitoba and Minnesota (Masters, 1970). *Colias scudderi* (including *harroweri*) is also a willow feeder, but not restricted to bogs and possibly not even occurring in bogs. It is found in mountain meadows in Colorado and New Mexico.

Dos Passos (1964) should be revised as follows in regards to *Colias scudderii*:

292 *Colias gigantea* Strecker, 1900
  a. *g. gigantea* Strecker, 1900
  b. *g. mayi* Chermock & Chermock, 1940
  c. *g. harroweri* Klots, 1940
292½ *Colias scudderii* Reakirt, 1865
  a. *s. scudderii* Reakirt, 1865
  b. *s. ruckesi* Klots, 1937

Or, as an alternative arrangement, if you prefer:

292 *Colias scudderii* Reakirt, 1865
  a. *s. gigantea* Strecker, 1900
  b. *s. mayi* Chermock & Chermock, 1940
  c. *s. harroweri* Klots, 1940
  d. *s. scudderii* Reakirt, 1865
  e. *s. ruckesi* Klots, 1937

You will notice that I have arranged the subspecies in geographical order; north to south and west to east. This seems to me the preferable treatment for subspecies, which are, in fact, geographical populations. Arrangements by alphabetical or chronological orders are completely artificial and since subspecies are assumed to have evolved by divergence there is no justification for the taxonomist to attempt to devise a phylogenetic order for them.

I have omitted *Colias astraea* Edwards which dos Passos placed under *C. scudderii* in his checklist. It is my opinion that *astraea* is a representative of the *Colias alexandra/christina* complex. F. M. Brown of Colorado Springs is currently studying the types of butterflies described by W. H. Edwards; I will leave to him the perogative of establishing the true identity of *astraea.*

ACKNOWLEDGEMENTS

I wish to thank Dr. Frederick A. Rindge of the American Museum of Natural History, New York, Dr. William D. Field of the U.S. National Museum, Washington, Mr. Harry K. Clench of Carnegie Museum, Pittsburgh, and Mr. Herb Copland of the Manitoba Museum of Man and Nature, Winnipeg for allowing me access to the collections of their respective institutions, without which this study would have been impossible. I also wish to thank Dr. Alexander B. Klots, of the American Museum, for his extremely helpful correspondence over the past four years, which has been a considerable aid in formulating this paper.

LITERATURE CITED

CHERMOCK, F. H. & R. L. CHERMOCK, 1940. Some new diurnal Lepidoptera from the Riding Mountains and the Sand Ridge, Manitoba. *Canadian Ent.*, 72: 81-83.

DOSPASSOS, C. F., 1964. A synonymic list of the Nearctic Rhopalocera. *Memoir No. 1, The Lepid. Soc.*, 145 pp.

HOVANITZ, W., 1950. The biology of *Colias* butterflies. I. The distribution of the North American species. *Wasmann Jour. Biol.*, 8: 49-75.

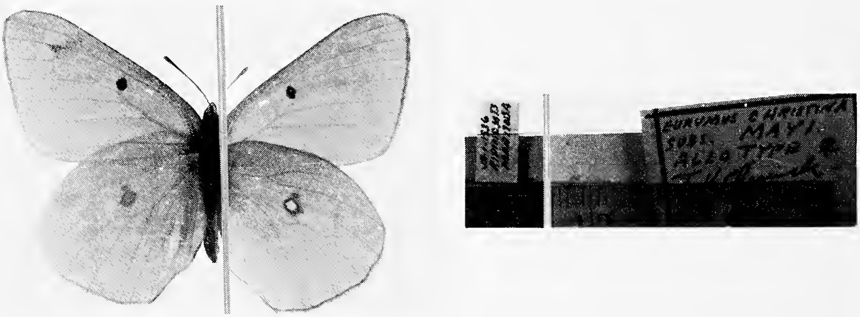
1950a. The biology of *Colias* butterflies. II. Parallel geographical variation of dimorphic color phases in North American species. *Wasman Jour. Biol.*, 8: 197-219.

KLOTS, A. B., 1940. New butterfly subspecies from Wyoming (Nymphalidae, Pieridae). *American Museum Novit.*, 1054: 1-6.

1951. A field guide to the butterflies. Houghton-Mifflin Company, Boston, 349 pp.

1961. Genus *Colias*. in Ehrlich, P. R. & A. H. Ehrlich. How to know the butterflies. Wm. C. Brown Co., Dubuque, Iowa, 262 pp.

MASTERS, J. H., 1970. Records of *Colias gigantea* Strecker (Pieridae) from southeast Manitoba and ? Minnesota. *Jour. Res. Lepid.*, 8: 129-132.



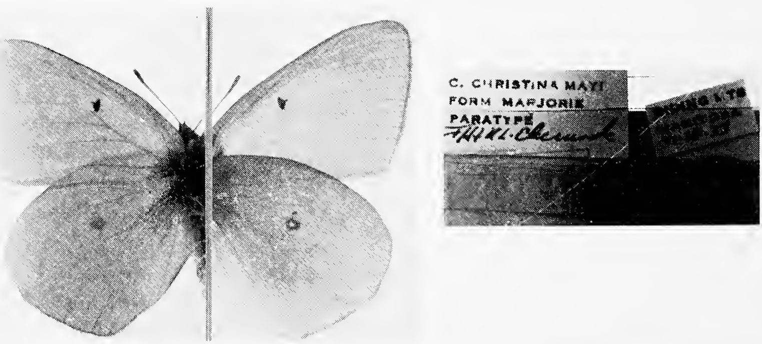


Fig. 1. Allotype female *Colias* christina mayi Chermock & Chermock. Riding Mountain, Manitoba, VII-1-1936. Natural scale. Upper side left, under side right.

Fig. 2. Paratype female *Colias christina mayi* form *marjorie* Chermock & Chermock. Riding Mountain, Manitoba, VI-29-1933. Natural scale. Upper side left, under side right.

Journal of Research on the Lepidoptera 9(4):233-242, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

LARVAL FOODPLANT RECORDS FOR NORTH AMERICAN RHOPALOCERA PART 2

JOHN F. EMMEL, OAKLEY SHIELDS and DENNIS E. BREEDLOVE

University of California School of Medicine, San Francisco, California
Department of Entomology, University of California, Davis, California
Department of Botany, California Academy of Sciences, San Francisco, California

THIS IS THE SECOND IN A SERIES of papers on butterfly larval foodplants. In our first paper (1969), we reviewed the extensive literature on foodplants, described sources of error in reporting foodplants, and presented a method of reporting foodplants which would leave possible determination errors open to correction through deposition of both plant and butterfly material for the use of future workers. Two additional papers have recently come to our attention (Hovanitz, 1969; Hovanitz & Chang, 1965). Herein we report 51 foodplant records for 35 species or subspecies of North American butterflies.

Most of the plant determinations were made by one of us (D.E.B.) who was assisted on some identifications by John Thomas Howell, California Academy of Sciences. We wish to thank James L. Reveal, Department of Botany, University of Maryland, for identifying the *Eriogonum* species. This work was supported largely by grants from the Allyn Foundation, Sarasota, Florida.

FOODPLANT RECORDS

(The format has been changed slightly from the first paper.) Each plant species name is followed by the collector's plant specimen number (for either J. F. Emmel or O. Shields); this in turn is followed by the abbreviation for the herbarium of

deposition for that plant specimen (CAS = California Academy of Sciences, San Francisco, California; DS = Dudley Herbarium, Stanford University, Stanford, California; NA = United States National Arboretum, Washington, D.C.). The plant family is also given in parantheses following the herbarium abbreviation. All butterfly material was collected by J.F.E. and O.S. unless otherwise specified and is deposited at the Los Angeles County Museum of Natural History, Los Angeles, California.

PAPILIONIDAE

1. *Papilio rutulus* Lucas. Nevada: Lander Co.; 4 to 5 road miles E. of Carroll Summit, 6600′, along highway near stream, June 14, 1969; female oviposited at 2:20 p.m. PST on leaf of *Salix exigua* Nutt., *J. F. Emmel 164* (CAS); (Salicaceae).

2. *Parnassius phoebus behrii* Edwards. (A) California: Mono Co.; north slope of Mt. Dana at lower end of Glacier Canyon, 10,800-11,200′, on benches on steep rocky slope, August 8, 1969; female oviposited at 9:30 a.m. PST on soil near *Sedum rosea* (L.) Scop. ssp. *integrifolium* (Raf.) Hult., *J. F. Emmel 213* (CAS); (Crassulaceae).

   (B) California: Tuolumne Co.; NW above Upper Gaylor Lake, 11,000′, NW of Tioga Pass, on open gravelly slope, August 9, 1969; female oviposited at 10:40 a.m. PST on shrub 6 inches from *Sedum lanceolatum* Torr., *J. F. Emmel 217* (CAS); (Crassulaceae).

3. *Parnassius phoebus rubina* Wyatt. (A) Nevada: Elko Co.; slope ½ air mile S. of Bonanza Gulch, 8200′, Jarbidge Mts., on gravelly slope, July 22, 1969; female oviposited at 2:30 p.m. PST on soil near *Sedum lanceolatum* Torr., *J. F. Emmel 193* (CAS); (Crassulaceae).

   (B) Same locality as 3A above; July 23, 1969; female oviposited at 11:20 a.m. PST on a grass near *Sedum lanceolatum* Torr., specimen identical to *J. F. Emmel 193*.

   (C) Nevada: Elko Co.; hill 2/3 air mile E. of Angel Lake, 8200′, East Humboldt Range, on gravelly slope, July 27, 1969; at 1:10 p.m. PST, female walked over and attempted oviposition on *Sedum lanceolatum* Torr., *J. F. Emmel 198* (CAS); (Crassulaceae).

PIERIDAE

1. *Pieris beckerii* Edwards. (A) Nevada: Lander Co.; Kingston Canyon, 6600′, Toiyabe Range, along road in canyon bottom, June 13, 1969; female oviposited at 12:30 p.m. PST on leaf of *Sisymbrium loeseli* L., *J. F. Emmel 155* (CAS); (Cruciferae).

   (B) Nevada: Lander Co.; 4 to 5 road mi. E. of Carroll Summit, 6600′, along highway near stream, June 14, 1969; female oviposited at 2:25 p.m. PST on leaf underside of *Lepidium perfoliatum* L., *J. F. Emmel 165* (CAS); (Cruciferae).

   (C) Nevada: White Pine Co.; along road between North Creek and Kalamazoo Creek, between North Creek and summit of range, Schell Creek Range, July 5, 1969; female oviposited at 1:45 p.m. PST on leaf of *Descurainea sophia* (L.) Webb., *J. F. Emmel 181* (CAS): (Cruciferae).

   (D) Nevada: Nye Co.; Jett Canyon, 6300-6800′, Toiyabe Range, along dirt road, July 10, 1969; female oviposited at 2:15 p.m. PST on leaf of *Sisymbrium loeseli* L., *J. F. Emmel 184* (CAS); (Cruciferae).

2. *Pieris sisymbrii* Boisduval. (A) California: Kern Co.; in desert wash bottom, 2500′, small canyon 2.2 road miles SW of Jawbone Canyon turnoff on State Hwy. 14, March 23, 1968, leg. JFE only; female oviposited on leaf underside of *Caulanthus coulteri* Wats., *J. F. Emmel 50* (CAS); (Cruciferae).

   (B) California: Napa Co.; hills N. of road above Pope Creek and Maxwell Creek, in steep, rocky gulch on S. slope of hill, April 7, 1968, leg. JFE only; female oviposited on leaf underside of *Streptanthus glandulosus* Hook., *J. F. Emmel 57* (CAS); (Cruciferae).

   (C) California: Mariposa Co.; small ravine N. of road, ca. 0.4 road mile W. of Yosemite National Park boundary on Hwy. 140, near El Portal, 2050-2250′, April 12, 1970, leg. JFE only; ovum on leaf underside of *Arabis glabra* (L.) Bernh., *J. F. Emmel 258* (CAS); (Cruciferae). Ovum was reared to a mature larva which died and rotted; color pattern and morphology of this larva was compared with color photographs of *P. sisymbrii* larvae reared from ova laid by confined females, and found to be indistinguishable.

3. *Pieris protodice* Boisduval & Le Conte. (A) California: Riverside Co.; N. end of Coxcomb Mts., on flats ca. 2 miles N. of base of mountains, March 26, 1969; mature larva feeding on flowers of *Lepidium fremontii* Wats., *J. F. Emmel 148* (CAS); (Cruciferae). Reared to adult; male emerged April 7, 1969.
   (B) Utah: Duchesne Co.; 23 road miles SW of Duchesne on Utah State Hwy. 33, Indian Canyon, along roadside, August 17, 1969; female oviposited at 9:10 a.m. MST on leaf underside of *Malcomia africana* (L.) R. Br., *J. F. Emmel 218* (CAS); (Cruciferae). This female is somewhat intermediate between *P. protodice* and *P. occidentalis* Reakirt, and may represent the latter species.
4. *Pieris occidentalis* Reakirt. Nevada: Humboldt Co.; Martin Creek Ranger Station, 7000′, Santa Rosa Range, in canyon bottom near stream, July 20, 1969; female oviposited at 10:25 a.m. PST on flower bud of *Thlaspi arvense* L., *J. F. Emmel 192* (CAS); (Cruciferae).
5. *Pieris napi oleracea* Harris. California: Mariposa Co.; small ravine N. of road, ca. 0.4 road mile W. of Yosemite National Park boundary on Hwy. 140, near El Portal, 2050-2250′, April 12, 1970, leg. JFE only; ovum on leaf underside of *Arabis glabra* (L.) Bernh., *J. F. Emmel 258* (CAS); (Cruciferae). Reared to adult; male emerged May 8, 1970.
6. *Pieris rapae* (Linnaeus). Utah: Uintah Co.; Merkley Park, N. of Vernal, along roadside, August 20, 1969; female oviposited at 11:00 a.m. MST on leaf underside of *Cleome serrulata* Pursh, *J. F. Emmel 221* (CAS); (Capparidaceae). Numerous other *P. rapae* adults were noted in close association with this plant at this locality.
7. *Colias meadii* Edwards. (A) Wyoming: Albany Co.; Lewis Lake Campground, 11,000′, Medicine Bow Mts., in dry meadow, August 22, 1968; female oviposited at 10:10 a.m. MST on leaf underside of *Trifolium parryi* Gray, *J. F. Emmel 121* (CAS); (Leguminosae). A second *C. meadii* female was observed to oviposit on this same *Trifolium* species at 10:30 a.m. MST in the same locality.
   (B) Same locality and date as for 7A above; at 11,100′, on well-drained rocky benches; female oviposited at 10:20 a.m. MST on leaf upperside of *Trifolium dasyphyllum* T. & G., *J. F. Emmel 122* (CAS); (Leguminosae).

(C) Colorado: Dolores Co.; 1 mile SW of Lizard Head Pass, 10,000′, on open dry ground, August 31, 1968; female oviposited at 12:15 p.m. MST on leaf of *Astragalus alpinus* L., *J. F. Emmel 134* (CAS); (Leguminosae).

8. *Colias eurytheme* Boisduval. California: Modoc Co.; 1 road mile E. of town of Pine Creek, E. of Hwy. 395, Warner Mts., in dry meadow near stream, July 15, 1968; albinic female oviposited on leaf of *Vicia americana* Muhl., *J. F. Emmel 80* (CAS); (Leguminosae).

9. *Colias philodice* Godart. Colorado: Montezuma Co.; Morefield Canyon, 7800′, Mesa Verde National Park, in dry meadow September 1, 1968; female oviposited at 1:00 p.m. MST on leaf underside of *Hedysarum boreale* Nutt., *J. F. Emmel 137* (CAS); (Leguminosae).

10. *Anthocharis sara thoosa* Scudder. California: San Bernardino Co.; canyon above Bonanza King Mine, 4500′, E. side of Providence Mts., on rocky slope above wash, March 28, 1969; two ova on flower buds of *Arabis perennans* Wats., *J. F. Emmel 152* (CAS); (Cruciferae). Both were reared to pupae; pupal morphology was indistinguishable from that of pupae of other *A. sara* populations reared by the authors. One pupa died several days after pupation. An adult male formed in the other pupa, but failed to emerge; this was dissected from the pupal shell on January 18, 1970. The wing pattern closely resembled that of *A. sara thoosa* adults from the Providence Mts.

NYMPHALIDAE

1. *Limenitis weidemeyerii nevadae* Barnes & Benjamin. Nevada: Clark Co.; Sawmill Canyon, 6700′, 4 air miles NW of Mormon Well, E. side Sheep Range, in dry wash of canyon bottom, July 2, 1969; female oviposited at 7:45 a.m. PST on leaf tip of *Amelanchier utahensis* Koehne, *J. F. Emmel 177* (CAS); (Rosaceae).

2. *Limenitis weidemeyerii latifascia* Perkins & Perkins. (A) Nevada: Nye Co.; Jett Canyon, 6500′, Toiyabe Range, on rocky slope near canyon bottom, July 10, 1969; female oviposited at 12:10 p.m. PST on leaf tip of *Holodiscus boursieri* (Carr.) Rehd., *J. F. Emmel 185* (CAS); (Rosaceae).

(B) Nevada: Nye Co.; Jett Canyon, 6800′, Toiyabe Range, along stream, July 10, 1969; female oviposited at 12:30 p.m. PST on leaf tip of *Salix exigua* Nutt., *J. F. Emmel 186* (CAS); (Salicacae). Female was not captured, but field identification was positive.

(C) California: Mono Co.; Cottonwood Canyon, 7300′, S. of Bodie, on rocky canyon slope, July 14, 1969; female oviposited at 11:20 a.m. PST on leaf tip of *Holodiscus microphyllus* Rydb., *J. F. Emmel 188* (CAS); (Rosaceae).

(D) Nevada: White Pine Co.; Kalamazoo Creek, 7000′, E. side of Schell Creek Range, along stream, July 31, 1969; female oviposited at 11:15 a.m. PST on leaf tip of *Populus angustifolia* James, *J. F. Emmel 204* (CAS); (Salicaceae).

3. *Limenitis lorquini* Boisduval. California: San Bernardino Co.; Little Cienega Seca, Highway 38, San Bernardino Mts., near edge of pond, June 27, 1969; female oviposited at 2:00 p.m. PST on leaf tip of *Salix lutea* Nutt., *J. F. Emmel 173* (CAS); (Salicaceae).

4. *Polygonia oreas oreas* (Edwards). California: Marin Co.; 0.4 road mile S. of Devil's Gulch Group Camp turnoff, along Lagunitas Creek, Samuel P. Taylor State Park, April 30, 1969; 3rd instar larva feeding on leaves of *Ribes divaricatum* Dougl., *J. F. Emmel 153* (CAS); (Saxifragaceae). Reared to adult; male emerged May 21, 1969.

5. *Chlosyne palla* (Boisduval). California: Stanislaus Co.; Del Puerto Canyon, 22 road miles W. of Patterson, on dry bank near stream, May 4, 1968; mature larva feeding on leaves of *Solidago californica* Nutt., *J. F. Emmel 143* (CAS); (Compositae). Reared to adult, female emerged May 25, 1968. Plant was not in flower on date larva was collected, so it was marked and collected on September 13, 1968, when in full bloom.

6. *Polydryas pola* (Boisduval). Colorado: Boulder Co.; west end of Bighorn Mountain, 8400′, E. of Gold Hill, in dry meadow, August 24, 1968; female oviposited at 11:30 a.m. MST (27 ova laid in 3 rows on leaf underside) on seedling of *Penstemon barbatus* ssp. *torreyi* (Benth.) Keck, *J. F. Emmel 124* (CAS); (Scrophulariaceae). Leaf and stem morphology were compared with nearby flowering plants of the same species.

7. *Euphydryas chalcedona chalcedona* (Doubleday). California: San Mateo Co.; crest of San Bruno Mts., 2 air miles W. of Sierra Point, 1000′, on open gravelly soil, March 21, 1969; mature larva feeding on leaves of *Plantago erecta* Morris, *J. F. Emmel 147* (CAS); (Plantaginaceae). Reared to adult; male emerged April 5, 1969.
8. *Speyeria nokomis nokomis* (Edwards). Utah: Duchesne Co.; 5½ road miles N. of Mountain Home, at turnoff to Yellowstone Creek, along Lake Fork Creek, in wet meadow, August 17, 1969; female oviposited at 1:40 p.m. MST on underside of dry twig 2 inches off ground and 6 inches from *Viola nephrophylla* Greene, *J. F. Emmel 219* (CAS); (Violaceae). No other *Viola* species were found in this meadow.
9. *Speyeria atlantis irene* (Boisduval). California: Siskiyou Co.; Brown's Meadow, on trail from Big Flat to Caribou Lake, Trinity Alps, in open dry meadow, July 23, 1968; female oviposited in ground litter near *Viola purpurea* Kell., *J. F. Emmel 95* (CAS); (Violaceae).
10. *Speyeria mormonia eurynome* (Edwards). Colorado: Routt Co.; Meadows Campground, 9600′, W. side of Rabbit Ears Pass, in grassy area near stream, August 27, 1968; female oviposited 2 ova in ground litter 2 inches from *Viola adunca* var. *bellidifolia* (Greene) Harrington, *J. F. Emmel 130* (CAS); (Violaceae). No other *Viola* species were noted in the immediate vicinity.
11. *Euptoieta claudia* (Cramer). Utah: Kane Co.; Stout Canyon, 6300′, 6 road miles N. of Glendale, on gravelly soil at lower edge of yellow pine zone, September 5, 1968; two 4th instar larvae feeding on flowers, fruits, and leaves of *Linum rigidum* Pursh, *J. F. Emmel 141* (CAS); (Linaceae). Both reared to adults; female emerged October 1, 1968; male emerged October 3, 1968.

LYCAENIDAE

1. *Apodemia mormo mormo* (Felder & Felder). (A) Nevada: Nye Co.; Ralston Valley, 5600′, 1½ road miles W. of jct. State Hwy. 8A and U.S. Hwy. 6, E. of Tonopah, T. 3 N., R. 43 E., in sandy area along highway, August 2, 1969; mature larva resting on stem of *Eriogonum kearneyi* Tidestr. var. *kearneyi, A. O. Shields 4* (NA); (Polygonaceae).

(B) California: San Bernardino Co.; 14 road miles from U.S. Hwy. 66 on Kelbaker Road, S. 21, T. 8 N., R. 13 E., S. of Granite Mts. (N. of Amboy), in large sandy wash, September 11, 1969; mature larva feeding on flowers of *Eriogonum plumatella* Dur. & Hilg. var. *plumatella, A. O. Shields 62* (NA); (Polygonaceae).

2. *Callipsyche behrii* (Edwards). Nevada: Lincoln Co.; Oak Springs Summit, 6200′, ca. 10 road miles W. of Caliente, on gentle slope among pinyons, July 3, 1969; female oviposited at 7:50 a.m. PST on stem of *Purshia tridentata* (Pursh) DC., *J. F. Emmel 178* (CAS); (Rosaceae).
3. *Strymon melinus* Hübner. California: San Diego Co.; Solana Beach, on dunes above beach, September 18, 1968; female oviposited at 11:40 a.m. PST on flower head of *Eriogonum parvifolium* Sm. in Rees var. *parvifolium, J. F. Emmel 145* (NA); (Polygonaceae). Several mature larvae found in flowerheads of nearby plants of this species; one reared to adult; female emerged October 12, 1968.
4. *Lycaena arota virginiensis* (Edwards). Nevada: Lander Co.; Kingston Canyon, 6600′, Toiyabe Range, on rocky talus slope above canyon bottom, June 13, 1969; several mature larvae feeding on leaves of *Ribes velutinum* Greene, *J. F. Emmel 158* (CAS); (Saxifragaceae). One reared to adult; male emerged July 5, 1969.
5. *Lycaena heteronea coloradensis* (Gunder). Wyoming: Carbon Co.; NE of Battle Lake, 9000′, Sierra Madre Mts., August 21, 1968; female oviposited at 12:30 p.m. MST on leaf underside of *Eriogonum subalpinum* Greene, *J. F. Emmel 120* (CAS); (Polygonaceae).
6. *Brephidium exilis* (Boisduval). Utah: Washington Co.; Watchman Campground, W. end of Zion National Park, on disturbed soil in open, August 30, 1969; 3 mature larvae feeding on flowers of *Salsola pestifer* A. Nels., *J. F. Emmel 224* (CAS); (Chenopodiaceae). One reared to adult; male emerged September 11, 1969.
7. *Plebejus saepiolus hilda* (Grinnell & Grinnell). California: San Bernardino Co.; Little Cienega Seca, Hwy. 38, San Bernardino Mts., in grassy meadow near small pond, June 27, 1969; female oviposited at 1:45 p.m. PST on flowerhead of *Trifolium wormskioldii* Lehm., *J. F. Emmel 172* (CAS); (Leguminosae). A number of lycae-

nid ova, indistinguishable from the ovum laid by this female, were found in the flowerheads of nearby plants of this *Trifolium*.

8. *Agriades glandon rustica* (Edwards). (A) Wyoming: Carbon Co.; NE of Battle Lake, 9000′, Sierra Madre Mts., open ground near hill summit, among sagebrush and lupines, August 20, 1968; female oviposited at 12:30 p.m. MST on leaf underside of *Androsace septentrionalis* var. *puberulenta* (Rybd.) Knuth., *J. F. Emmel 118* (CAS); (Primulaceae). About 5 additional lycaenid ova, indistinguishable from the ovum laid by this female, were found on nearby plants of this species. One was located on a leaf upperside, but the remainder were found on leaf undersides.

   (B) Colorado: Clear Creek Co.; above Guanella Pass, 11,700-11,800′, 11 road miles S. of Georgetown, on open gravelly slope, August 25, 1968; 17 ova found on leaves near plant bases of *Androsace septentrionalis* var. *subumbellata* A. Nels., *J. F. Emmel 126* (CAS); (Primulaceae). These ova were compared with ova dissected from an *A. glandon* female taken in the same locality, and found to be indistinguishable. Several *A. glandon* females in this locality showed pre-oviposition behavior toward this plant.

9. *Glaucopsyche lygdamus oro* Scudder. Colorado: Gunnison Co.; hills 1½ air miles SE of Gothic, 9400′, open grassy meadow, July 4, 1967; female oviposited at 11:00 a.m. MST on flower bud of *Vicia americana* Muhl. ex Willd., *J. F. Emmel 4* (DS); (Leguminosae).

10. *Glaucopsyche lygdamus* near *australis* Grinnell. California: Monterey Co.; sand dunes W. of intersection of Palm Ave. and Lake Dr., W. of Marina, 60-100′, March 21, 1970; female oviposited at 11:25 a.m. PST at base of flower bud of *Lotus scoparius* (Nutt.) Ottley, *J. F. Emmel 230* (CAS); (Leguminosae).

HESPERIIDAE

1. *Hesperia nevada* (Scudder). California: Alpine Co.; Ebbetts Pass, 8730′, open gravelly hilltop, August 7, 1969; female oviposited at 11:30 a.m. PST on leaf upperside of *Sitanion hystrix* (Nutt.) J. G. Sm., *J. F. Emmel 212* (CAS); (Gramineae).

LITERATURE CITED

HOVANITZ, W., 1969. Inherited and/or conditioned changes in host-plant preference in *Pieris*. *Ent. Exp. & Appl.* 12:729-735.

HOVANITZ, W., and V. C. S. CHANG, 1965. The alteration of host plant specificity in larvae of *Pieris rapae* by induction. *J. Res. Lepid.* 4:13-21.

SHIELDS, O., J. F. EMMEL, and D. E. BREEDLOVE, 1969. Butterfly larval foodplant records and a procedure for reporting foodplants. *J. Res. Lepid.* 8:21-36.

Journal of Research on the Lepidoptera 9(4):243-248, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A NEW SUBSPECIES OF *BOLORIA EUNOMIA* (NYMPHALIDAE) FROM WYOMING[1]

CLIFFORD D. FERRIS and DENNIS R. GROOTHUIS
University of Wyoming, Laramie, Wyoming; Douglas, Wyoming

Six subspecies of *Boloria eunomia* (Esper) are currently recognized (dos Passos, 1964). Based upon appearance (dorsal dark markings and ground color), these six subspecies can be broadly separated into three groups: a light group in which the dark markings are reduced and the ground color is tawny or yellow-brown; a dark group in which the dark markings are extensive, frequently giving a dark dusted aspect, and the ground color is orange-brown; and a single subspecies *denali* (Klots) which is quite pale and distinct. The light group consists of *caelestis* (Hemming), and *triclaris* (Hubner); the dark group is composed of *dawsoni* (Barnes and McDunnough), *laddi* (Klots) and *nichollae* (Barnes and Benjamin). There is considerable evidence, based upon unpublished reports from collectors, that *nichollae* is simply a melanic high altitude form of *dawsoni*. Results of collecting by Ferris in Alberta in 1970 bears this out. A cline was observed with altitude when *eunomia* were collected along a slope which ranged from a river bottom willow bog (elevation 6000′ approx.) to barren ridges above timber line (elevation 8000′ approx.). The higher altitude specimens are very dark and distinct.

The type localities and publication dates for the taxa cited are shown below:

caelestis T. L. Hall Valley, Park Co., Colorado, Hemming, 1933.

denali T. L. Mt. McKinley National Park, Alaska, Klots, 1940. (1940a).

triclaris T. L. probably Labrador, Hubner, 1821.

dawsoni T. L. Hymers, Ontario, Canada, Barnes and McDunnough, 1916.

laddi T. L. Lewis Lake, Albany Co., Wyoming, Klots, 1940. (1940b).

nichollae T. L. "Rocky Mtns." [Alberta implied], Barnes and Benjamin, 1926.

[1]Published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 464.

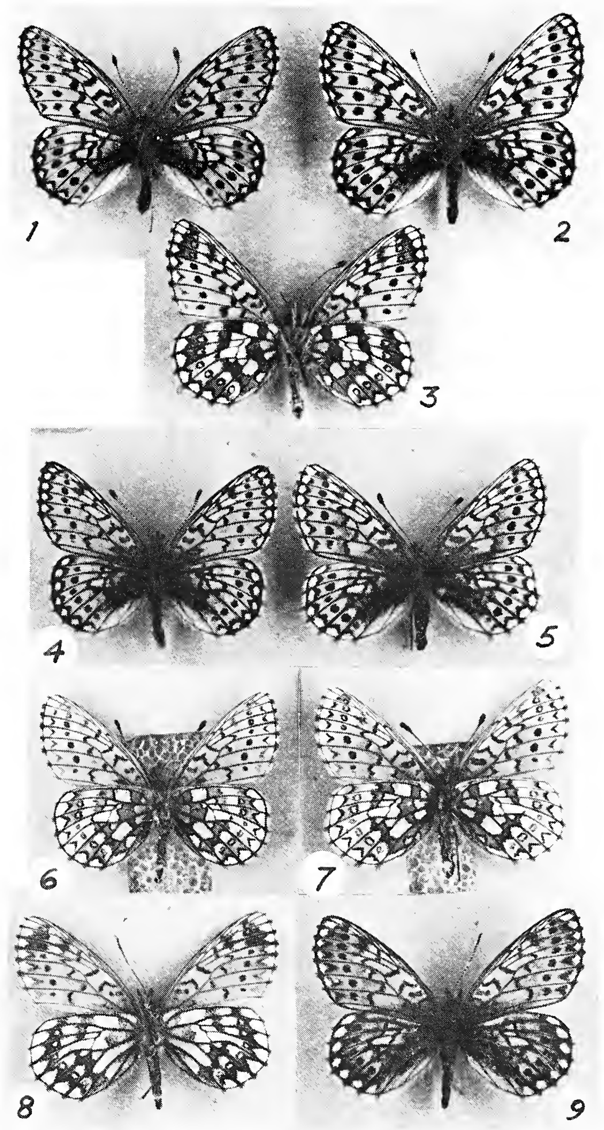


Fig. 1.—*Boloria eunomia laddi* (Klots). Topotypes from Lewis Lake, Snowy Range, Albany Co., Wyoming. Fig. 1, ♂ upper side, Fig. 2, ♀ upper side, Fig. 3, ♂ under side.
Boloria eunomia ursadentis Ferris and Groothuis. Paratypes from Beartooth Pass, Park Co., Wyoming. Fig. 4, ♂ upper side, Fig. 5, ♀ upper side, Fig. 6, ♂ under side, Fig. 7, ♀ under side, Fig. 8, aberrant ♀ under side, Fig. 9, aberrant ♀ upper side.

Three distinct forms of *Boloria eunomia* have been observed in Wyoming. In the southeastern part of the state, *laddi* flies and is restricted to alpine willow bogs in the Hudsonian Zone. A second form is represented by a small series of specimens from the Big Horn Mountains in the north-central portion of the state and appear to be intergrades between *laddi* and *dawsoni*. These specimens, collected by Dr. John S. Nordin in the Cloud Peak Wilderness Area in Johnson Co., are dorsally similar to *laddi*. Ventrally the overall color is intermediate between *laddi* and *caelestis*. The marginal chevrons on the secondaries are very pearly as in *dawsoni* rather than opaque as in *laddi*. The light flush in cells M_2 and M_3 is less pronounced than in *laddi* but not so obscure as in *dawsoni*. The third form is discussed below.

To date, *Boloria eunomia* has not been recorded from the Wind River Mountains or the western border of Wyoming. A very distinct form, however, has been taken on the Beartooth Plateau, Park Co., Wyoming and is the subject of the remainder of this paper.

While we are somewhat reluctant to add another subspecific name to the already long list under *eunomia*, we feel that the new subspecies is sufficiently distinct to warrant nomenclatural recognition. This insect belongs to the light group and in some respects is close to *denali*. While a few specimens have been taken in Hudsonian Zone wet willow bogs, the habitat of this subspecies appears to be the relatively dry gently sloping hillsides of the Arctic-Alpine Zone. In the Beartooth Mountains, this ecological zone contains a few areas in which dwarf willows grow along the run-off areas from the snow fields. The slopes generally face to the southeast. Here, in these isolated locations, is where the new subspecies appears to be most abundant.

We propose as the name of this subspecies *ursadentis* which is derived from the name of the type locality.

Boloria eunomia ursadentis Ferris and Groothuis New Subspecies

The new subspecies is separated from the other members of the light *caelestis-triclaris* group in a general way because dorsally the color is a more distinct yellow-brown or ochre than is found in its cogeners. This is especially true of the females. Description of new subspecies:

Males. Dorsal ground color ochraceous yellow brown with suggestion of orange, dark markings very finely penciled, dusting of dark scales basally on primaries and basally and along the

inner margin of the secondaries. Dorsal surface frequently appears faded and lightly dusted with dark scales. Ventral surface generally pale and lightly marked. Black markings on primaries very fine and light. Ventral secondary orange-brown patches reduced. Compared with other subspecies in the group, the discal area light bars in cells Sc + R_1 and Cu_2 are elongated; the pale color is virtually continuous from the cell and throughout cell M_2 being only slightly interrupted by a fine dark line at the cell end and in the median area, and slightly orange flushed just basad of the marginal chevron. Marginal spots distad of the black chevrons are very pale with only a slight suggestion of luminosity.

Females. Dorsally similar to the males but more tawny in appearance and with heavier dusting of dark scales. Marginal light spots quite pale and distinct. Ventrally as in male but paler. The light areas are almost white, being a pale buff, and do not show the orange flush characteristic of other members of the *eunomia* complex.

There is considerable variation in size of the specimens. The maximum and minimum lengths of the costal margins of the primaries for both sexes are:

male	1.5 - 1.7 cm.
female	1.7 - 1.8 cm.

Type Series. The type series consists of 24 ♂♂ and 8 ♀♀ of which 1 ♂ and 1 ♀ are strongly aberrant and several of the females appear atypical in the arrangement of markings. 10 ♂♂, 4 ♀♀ (1 of which is strongly aberrant) Beartooth Pass, ½ mile S. of Montana-Wyoming border, Park Co., Wyoming 24-vii-69, D. R. Groothuis collector; 13 ♂♂ (1 of which is aberrant), 3 ♀♀ Beartooth Pass, hillside north side of west slope of pass at summit (about 11,000′), Park Co., Wyoming 24-vii-70, C. D. Ferris collector; 1 ♂ and 1 ♀ Beartooth Pass, west slope, Highway 212, Shoshone N.F. (10,800′), Park Co., Wyoming 11-viii-65, E. M. Perkins, Jr. collector.

Holotype ♂. The holotype bears a red label handlettered in black ink: *Boloria eunomia ursadentis* Ferris/ & Groothuis/ Det: C. D. Ferris and a white label handlettered in black ink: Beartooth Pass/ Park Co. Wyo. ½ mi./ S. Mont.-Wyo./ Border. 24-vii-69/ Leg: D. R. Groothuis.

Allotype ♀. The aloltype bears a green label handlettered in black ink: *Boloria eunomia ursadentis* Ferris/ & Groothuis/ Det:

C. D. Ferris and a white label machine printed in black ink: Beartooth Pass, W./ slope, H. 212, Shoshone/ N.F., Park Co., Wyo./ 10800′ 11-viii-65/ leg. B. ["B:" in red ink, handlettered] Perkins. A smaller white label in machine printed black ink reads: A. C. Allyn/ Acc. 1970-2. B. stands for "Bud", the nickname of E. M. Perkins, Jr.

Paratypes. The 30 paratypes have been indicated above in the description of the type series.

The holotype, allotype, and one male paratype (the other Perkins specimen) are placed in the collection of the Allyn Museum of Entomology, Sarasota, Florida. Four paratypes are in the collection of J. H. Shepard, Berkeley, California. Additional paratypes will be distributed to various museum collections. Specimens from the type series will be retained in the C. D. Ferris collection and the D. R. Groothuis collection.

The plate shows specimens of *Boloria eunomia laddi* (topotypes) [Figs. 1, 2, 3] and *Boloria eunomia ursadentis* (paratypes) [Figs. 4-9]. An aberrant female of *ursadentis* is also figured [Figs. 8, 9].

In making this study, specimens of *Boloria eunomia* from Alberta, Colorado, Wyoming, Minnesota, Quebec, and the Yukon were examined as well as specimens of *denali* from Alaska. The original descriptions were consulted.

It is interesting to note that in Alberta two distinct forms of *eunomia* fly: a light form and a dark form. The dark form, to which the name *nichollae* has been applied appears to be found only above timber line in the regions north of Banff. Some discussion that *nichollae* may be only an altitudinal form appeared above. Specimens from southern Alberta, even those taken above timber line on Plateau Mountain (elevation 8200′), are much paler than *nichollae* and resemble the *laddi-dawsoni* intergrade from the Big Horn Mountains in Wyoming.

The possibility that *ursadentis* is an altitudinal form has been considered. This has been ruled out for the present for two reasons. The first is that *laddi* flies at the same altitude and is a dark subspecies; *nichollae* is also a dark subspecies. The second is that in other Nymphalidae in Wyoming, the facies become darker with increasing altitude as a general rule. The new subspecies *ursadentis* is pale by comparison with *laddi* and the more northern dawsoni. There are a few specimens in the type series of *ursadentis* which tend toward *laddi*. The majority of the specimens are pale by comparison with some tending toward *denali*.

LITERATURE CITED

BARNES, W. and F. H. BENJAMIN. 1926. Notes on diurnal lepidoptera with additions and corrections to the recent "List of Diurnal Lepidoptera." *Bull. So. Calif. Acad. Sci.,* 25: 88-98.

BARNES, W. and J. McDUNNOUGH. 1916. Some new races of North American Lepidoptera. *Can. Ent.,* 48: 221-224 [Rhopalocera portion].

HEMMING, A. F. 1933. Holarctic butterflies: miscellaneous notes on nomenclature. *Entomologist,* 66: 275-279.

HÜBNER, J. 1821. Sammlung Exostischer Schmetterlinge. Augsburg. [In several volumes with various dates].

KLOTS, A. B. 1940a. A new Brenthis from Alaska (Lepidoptera. Nymphalidae), *J. N. Y. Ent. Soc.,* 48: 413-414.

________ 1940b. New butterfly subspecies from Wyoming (Nymphalidae, Pieridae). Amer. Mus. Nat. Hist. *Novitates* 1054: 1-6.

dos PASSOS, C. F. 1964. A synonymic list of the Nearctic Rhopalocera. *Memoir No. 1, The Lepidopterists' Society.* vi + 145 pp.

Journal of Research on the Lepidoptera 9(4):249-256, 1970(1971)

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A LIST OF ANTILLEAN BUTTERFLIES

JAMES A. SCOTT
60 Estes Street, Lakewood, Colorado 80226

No complete list has appeared for the butterflies of the Antilles. The following list was compiled by the author from approximately 100 literature sources. The list is the data used in the author's zoogeographic analysis of the butterfly fauna (in press). The papers used to compile the list can be found in the Literature Cited by Torre y Callejas (1954), except for those listed at the end of this paper.

Different numbers in the list refer to different subspecies; the nomenotypical subspecies is not necessarily number 1.

The author would like to thank F. M. Brown, who provided an unpublished manuscript on Jamaica.

ANTILLEAN BUTTERFLIES

COMPILED BY JAMES A. SCOTT FROM ALL AVAILABLE LITERATURE (APPROXIMATELY 100 PUBLICATIONS)

ABBREVIATIONS OF THE ISLANDS FOLLOW, IN ORDER ACROSS THE TOP OF EACH PAGE

F = FLORIDA
B = BAHAMAS
C = CUBA
I = ISLE OF PINES
C = CAYMAN ISLANDS
J = JAMAICA
H = HISPANIOLA
M = MONA ISLAND
P = PUERTO RICO
V = VIRGIN ISLANDS
A = ANGUILLA TO MONTSERRAT
G = GUADELOUPE AND DOMINICA
M = MARTINIQUE AND ST LUCIA
S = ST. VINCENT, BARBADOS, AND GRENADA
T = TRINIDAD, TOBAGO
S = SOUTH AMERICA
C = MEXICO TO PANAMA (CENTRAL AMERICA)

ISLAND ABBREVIATIONS	F	B	C	I	C	J	H	M	P	V	A	G	M	S	T	S	C
PAPILIONIDAE, PAPILIONINAE, 21 SPECIES																	
CRESSIDINI, 4 SPECIES																	
BATTUS POLYDAMAS	11	11	12		12	8	6		6	9	10	4	1	3	13	13	13
BATTUS GUNDLACHIANUS			1														
BATTUS DEVILLIERS			1				1										
BATTUS ZETES							1										
PAPILIONINI, 14 SPECIES																	
PAPILIO MACHAONIDES							1										
PAPILIO THERSITES						1											
PAPILIO THOAS			2			3									4	4	1
PAPILIO ANDRAEMON		3	4	1	2	5											
PAPILIO ARISTODEMUS	4		1		2		3		3								
PAPILIO CRESPHONTES	1	1	1														1
PAPILIO CAIGUANABUS			1														
PAPILIO ANDROGEUS			1			1	1		1				1		2	2	1
PAPILIO ARISTOR							1										
PAPILIO **ASTYALUS**													1			3	2
PAPILIO HOMERUS						1	1										
PAPILIO OXYNIUS			1														
PAPILIO PELAUS			2			1	3		3								
PAPILIO POLYXENES	1		2													3	1
GRAPHIINI, 3 SPECIES																	
GRAPHIUM ZONARIA							1										
GRAPHIUM MARCELLINUS						1											
GRAPHIUM CELADON			1	1													
PIERIDAE, PIERINAE, 7 SPECIES																	
ASCIA MONUSTE	1	3	3	3	3	3	3	3	3	4	4	4	4	2	2	2	2
ASCIA JOSEPHINA			5			2	1		4								3
MELETE SALACIA			1	1			1										2
APPIAS PEREGRINA							1										
APPIAS PUNCTIFERA									1	1							
APPIAS DRUSILLA	2	3	3	3	8	4	6	6	6	6	6	7	5	5	1	1	1
PIERIS PROTODICE	1		1														1
PIERIDAE, COLIADINAE, 41 SPECIES																	
KRICOGONIA CASTALIA	1	1	1			1	1		1						1	1	1
KRICOGONIA CABRERAI			1														
NATHALIS IOLE	1	1	1			1	1									1	1
COLIAS CESONIA	1		1				1									1	1
COLIAS CYNOPS							1										
ANTEOS MAERULA			2			2	2		2						1	1	1
ANTEOS CHLORINDE			1													2	1
PHOEBIS SENNAE	1	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
PHOEBIS PHILEA	1		1				1		1						2	2	2
PHOEBIS AVELLANEDA			1				1										
PHOEBIS ARGANTE			1			4	4		2			2		2	3	3	3
PHOEBIS AGARITHE	1	3	3	3		3	3		3			4	4		2	2	2
PHOEBIS TRITE							2		2		2	2	2		1	1	1
PHOEBIS EDITHA							1										
PHOEBIS ORBIS			2				1										
PHOEBIS GODARTIANA							1		1								
PHOEBIS HARTONIA						1											
PHOEBIS STATIRA	4	5	5	5		5	3		3				3		1	1	2
PHOEBIS NELEIS		1	1	1	1												
EUREMA ALBULA														1	1	1	1
EUREMA LUCINA			1	1													
EUREMA PRIDDYI				1			2										
EUREMA DAIRA	4	3	3	3	3	3	3	3	3	3	3	3		1	2	2	2
EUREMA ELATHEA		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EUREMA MESSALINA		1	2		2	2											
EUREMA PORTORICENSIS									1								
EUREMA ADAMSI						1											
EUREMA AMELIA			1	1													
EUREMA NICIPPIFORMIS							1										
EUREMA NICIPPE	1	1	1	1	1	1	1		1							1	1
EUREMA PROTERPIA			1			1	1									1	1
EUREMA PYRO							1										
EUREMA BOISDUVALIANA			1														1
EUREMA EUTERPIFORMIS							1										
EUREMA LARAE			1														
EUREMA LISA	2	2	2	2	2	2	2	2	2	2	2	2					1
EUREMA NEDA			1													1	1
EUREMA NISE	3		3			3				2		2	2	2	1	1	3
EUREMA CHAMBERLAINI	1	1															
EUREMA LEUCE							4		3		2	2	2		1	5	
EUREMA DINA		3	1	1		2	4										5

ISLAND ABBREVIATIONS	F	B	C	I	C	J	H	M	P	V	A	G	M	S	T	S	C
PIERIDAE, DISMORPHIINAE, 1 SPECIES																	
DISMORPHIA SPIO			2				1		1								
NYMPHALIDAE, DANAINAE, 9 SPECIES																	
DANAUS PLEXIPPUS	1	1	2		2	3	3	3	3	4	4	5	5	5	5	5	5
DANAUS GILIPPUS	5	5	5	5	5	3	4		4				4		2	2	1
DANAUS ERESIMUS		2	2		2	2	2						1	1	1	1	1
DANAUS CLEOPHILE						1	1		1								
LYCOREA CERES			1				3		3						2	2	2
ANETIA NUMIDIA			2				1										
ANETIA PANTHERATA			2				1										
ANETIA CUBANA			1														
ANETIA JAEGERI							1										
NYMPHALIDAE, ITHOMIINAE, 2 SPECIES																	
HYMENITIS CUBANA			1														
HYMENITIS DIAPHANUS						1	2										
NYMPHALIDAE, NYMPHALINAE, 57 SPECIES																	
HELICONIINI, 7 SPECIES																	
PHILAETHRIA DIDO			1				1								1	1	1
DIONE JUNO							2						2	2	2	2	1
AGRAULIS VANILLAE	1	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	2
COLAENIS IULIA	2	4	3	3	3	5	6		7	7	8	9	10	11	1	1	1
HELICONIUS ALIPHERUS														1	1	1	1
HELICONIUS ISABELLAE			1				2		2						3	3	4
HELICONIUS CHARITONIUS	6		1	1	1	2	3	5	5	5	4				8	8	7
MELITAEINI, 6 SPECIES																	
ATLANTEA PEREZI			2			3			1							4	4
ANTILLEA PELOPS			1			2	1		1		1						
ANTILLEA PROCLEA						1											
PHYCIODES PHAON	1		1		1												1
PHYCIODES THAROS	1	1															1
PHYCIODES FRISIA	1	1	1	1		1	1		1							2	2
ARGYNNINI, 2 SPECIES																	
EUPTOIETA HEGESIA		1	1	1	1	1	2		2						3	3	3
EUPTOIETA CLAUDIA	1		1			1											1
ERGOLINI, 15 SPECIES																	
MYSCELIA ANTHOLIA							1										
DIAETHRIA DOMINICANA													1			1	
DIAETHRIA CODOMANNUS													1		1	1	
EUNICA MONIMA	1		1			1	1	1	1							1	1
EUNICA TATILA	2		1			1	1		1	1						2	2
EUNICA PUSILLA			2													1	1
EUNICA MACRIS			1												2	2	
MESTRA HYPERMESTRA												1	1	1	2	2	
MESTRA TELEBOAS							1										
MESTRA DORCUS						1											
HAMADRYAS FEBRUA						1	1								2	2	3
HAMADRYAS FEROX			1				1	1	1							2	2
HAMADRYAS FERONIA							1						2		2	2	3
HAMADRYAS AMPHINOME			1												2	2	1
BIBLIS HYPERIA							1		1	1	1	1	1		2	2	2
LIMENITINI, 13 SPECIES																	
LIMENITIS CYTHEREA													1		1	2	2
LIMENITIS IPHICLA			3	3		2									1	1	1
LIMENITIS GELANIA							1		2								
DYNAMINE EGAEA			1			1	2										
DYNAMINE MYLITTA			1												2	2	3
MARPESIA MARIUS			1			1	1		1						1	1	1
MARPESIA ELEUCHA		2	2	2		1	2										
MARPESIA PETREUS	1								1		1	1	2		2	2	2
HISTORIS ODIUS			1	1		1	1		1			2	2	2	2	2	2
HISTORIS ACHERONTA			1			2	1		1							3	3
COLOBURA DIRCE			1			2	3		3						4	4	4
PYRRHOGYRA NEAEREA													1		1	1	1
LUCINIA SIDA		2	1	1		3	4										
APATURINI, 3 SPECIES																	
ASTEROCAMPA ARGUS			1	1			1		1								2
DOXOCOPA LAURE			1			2									3	3	4
DOXOCOPA THOE																	

ISLAND ABBREVIATIONS	F	B	C	I	C	J	H	M	P	V	A	G	M	S	T	S	C
NYMPHALINI, 11 SPECIES																	
HYPANARTIA PAULLUS			1			1	1		1								
VANESSA VIRGINIENSIS	1		1			1	1		1							1	1
VANESSA ATALANTA	1		1			1	1										1
VANESSA CARDUI	1		1			1	1		1		1	1	1	1	1	1	1
JUNONIA COENIA	1	1	1	1													1
JUNONIA EVARETE	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3
HYPOLIMNAS MISIPPUS			1			1	1	1	1	1	1	1	1	1	1	1	
SIPROETA STELENES			2	2	1	1	1		1	1	1				3	3	3
ANARTIA JATROPHAE	1	1	1	1	2	2	3		4	4	6	6	6	6	6	6	7
ANARTIA LYTREA			2	2		1	1				3						4
ANARTIA AMALTHEA														1	1	1	1
NYMPHALIDAE, CHARAXINAE, 7 SPECIES																	
ANAEA MARTHESIA			1	1			1		1						1	1	1
ANAEA CLYTEMNESTRA			1													2	2
ANAEA PORTIA	1		2			3	4		5	6	7						8
ANAEA GLYCERIUM						1										2	2
ANAEA ECHEMUS		1	1		1												1
ANAEA VERTICORDIA		1					1					2	3	3			
PREPONA ANTIMACHE			2				1		1						3	3	3
NYMPHALIDAE, SATYRINAE, 20 SPECIES																	
CALISTO MONTANA							1										
CALISTO HEROPHILE		2	1	1													
CALISTO SIBYLLA		1															
CALISTO ZANGIS						1											
CALISTO NUBILA									1								
CALISTO LOXIAS							1										
CALISTO ARCHEBATES							1										
CALISTO CHRYSAOROS							1										
CALISTO ARCAS							1										
CALISTO TRAGIUS							1										
CALISTO HYSIUS							1										
CALISTO CONFUSA							1										
CALISTO OBSCURA							1										
CALISTO LYCEIUS							1										
CALISTO GRANNUS							1										
CALISTO ELELEUS							1										
CALISTO MICHENERI							1										
CALISTO PULCHELLA							1										
CALISTO SMINTHEUS			1														
CALISTO DEBARRIERA							1										
LIBYTHEIDAE, 2 SPECIES																	
LIBYTHEANA MOTYA			1			2	2		2			3					
LIBYTHEANA BACHMANNI	1		1														1
LYCAENIDAE, RIODININAE, 1 SPECIES																	
APODEMIA CARTERI		1	2														
LYCAENIDAE, LYCAENINAE, 36 SPECIES																	
THECLINI, 25 SPECIES																	
EUMAEUS ATALA	1	2	2	2													
CHLOROSTRYMON MAESITES	1	1	1			1			1			2		3	3	3	3
CHLOROSTRYMON SIMAETHIS			1			2	1		1	1	1	1		1	1	1	3
CALLOPHRYS CRETHONA						1											
NESIOSTRYMON CELIDA			1			2			3								
PSEUDOLYCAENA MARSYAS														1		2	3
HETEROSMAITIA BOURKEI						1											
ALLOSMAITIA COELEBS			1														
ALLOSMAITIA FIDENA							1		1								
ALLOSMAITIA PIPLEA												1		1			
STRYMON ACIS	5	6	4		7	8	3		2	2	2	2					
STRYMON MARTIALIS	1	1	1	1	1	1											
STRYMON RUFOFUSCA														1		1	1
STRYMON BUBASTUS									1	1	1	1	1	1	2	2	
STRYMON COLUMELLA	2	3	3	3	3	3	1		4								5
STRYMON ANTIGUA										1	1						
STRYMON TOUSSAINTI							1										
STRYMON CRISTOPHEI							1										
STRYMON LIMENIA			1			1	1		1								

ISLAND ABBREVIATIONS	F	B	C	I	C	J	H	M	P	V	A	G	M	S	T	S	C
STRYMON BAZOCHII			1			1	1								2	2	2
ELECTROSTRYMON PAN						1											
ELECTROSTRYMON ANGELIA		3	1			2	4		4	4							
ELECTROSTRYMON ANGERONA											1	1		1			
ELECTROSTRYMON DOMINICANA												1					
THECLA DEVA												1				1	1
PLEBEJINI, 11 SPECIES																	
LEPTOTES CASSIUS	1	1	1	1	1	1	1		1	3	3	2	2		4	4	5
LEPTOTES PERKINSAE						1											
HEMIARGUS DOMINICA						1											
HEMIARGUS AMMON		1	1	1	1												
HEMIARGUS WOODRUFFI									1	1	1						
HEMIARGUS HANNO	1	2	2		2	2	2		3	3	3	3	3	3	3	4	5
HEMIARGUS EREMBIS					1												
HEMIARGUS THOMASI	1	2					4	4									
PSEUDOCHRYSOPS BORNOI							1		1								
BREPHIDIUM EXILUS		3	2		2	2	2										1
BREPHIDIUM PSEUDOFEA	1	1															
HESPERIIDAE, PYRGINAE, 45 SPECIES																	
PHOCIDES PIGMALION	4	3	3	3	3		2		2						1	1	1
PHOCIDES LINCEA						1										2	
PROTEIDES MERCURIUS			2	2		3	4		5			6	6	7	1	1	1
PROTEIDES MAYSI			1	1													
EPARGYREUS ZESTOS	1	1					1		1	1	1	1	1	1	1	1	1
EPARGYREUS ANTAEUS						1	1										
EPARGYREUS SPANNA							1										
POLYGONUS LEO	1	2	2	2		3	4		2	2	2	2			1	1	1
POLYGONUS MANUELI	1										2	2	2	2	1	1	1
CHIOIDES CATILLUS						3								4	2	2	1
CHIOIDES IXION							1										
CHIOIDES MARMOROSA			1														
AGUNA ASANDER			3	3		2	1								4	4	4
POLYTHRIX OCTOMACULATA							1								2	2	2
URBANUS PROTEUS	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
URBANUS DORANTES		3	3	3			2	2	2	2	4	4	4	4	1	1	1
URBANUS SIMPLICIUS							1								1	1	1
URBANUS ALBIMARGO							1									2	
ASTRAPTES TALUS			1				1		1					1	1	1	1
ASTRAPTES XAGUA			1				2										
ASTRAPTES ALARDUS			3	3			4								1	1	2
ASTRAPTES JAIRA						1											
ASTRAPTES CASSANDER			1	1													
ASTRAPTES ANAPHUS			2			2	2		2	2		2		2	1	1	1
CABARES POTRILLO			1			1	1								2	2	1
BURCA BRACO		2	1														
BURCA CONCOLOR		2	1														
BURCA STILLMANI							1										
BURCA HISPANIOLAE							1										
BURCA CUBENSIS			1														
ANTIGONUS EROSUS														1	1	1	1
ACHYLODES THRASO			4			2	5		3	3		3			1	1	1
GRAIS STIGMATICUS						2									1	1	3
TIMOCHARES RUPTIFASCIATA						1											2
ANASTRUS SEMPITERNUS			2			2	2								1	1	3
CHIOMARA ASYCHIS							4						4	4	1	1	2
CHIOMARA MITHRAX			1												1	1	1
GESTA GESTA			1			1	1								1	1	2
EPHYRIADES ARCAS			2	2		2	2	2	3	3	3					2	2
EPHYRIADES ZEPHODES			1			1	1		1	1	1				1	1	1
EPHYRIADES BRUNNEA	3	2	2	2		1						4					2
ERYNNIS ZARUCCO	1		1				1		1							2	2
PYRGUS CRISIA			1				2		2								
PYRGUS OILEUS	1		1	1		1	1	1	1	1	1	2	2	2	2	2	1
HELIOPETES ARSALTE							1								1	1	1
HESPERIIDAE, HESPERIINAE, 36 SPECIES																	
SYNAPTE MALITIOSA			1			1									3	3	2
PHERAEUS UNIA							1										
PYRRHOCALLES ANTIQUA		4	2	2		3	1		1								
CALLIMORMUS ALSIMO							1								1	1	1
CYMAENES TRIPUNCTUS	1		1	1	1	1	1	1	1	1					2	2	2
PERICHARES PHILETES			1			1	1		1						1	1	2

ISLAND ABBREVIATIONS	F	B	C	I	C	J	H	M	P	V	A	G	M	S	T	S	C
RHINTHON CUBANA			1			1									2	2	2
RHINTHON BUSHI							1										
OARISMA NANUS			1	1													
OARISMA STILLMANI							1										
HYLEPHILA PHYLEUS	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1
POLITES VIBEX	2						3		3		3			3	1	1	1
POLITES BARACOA	1		1	1			2										
WALLENGRENIA OTHO	6	1	1	1		3	2	2	7	7	4	4	4		5	5	6
ATALOPEDES NABOKOVI							1										
ATALOPEDES MESOGRAMMA		2	1	1			3		3								1
PARATRYTONE BATESI							1										
CHORANTHUS LILLIAE						1											
CHORANTHUS BORINCONA									1								
CHORANTHUS RADIANS		2	1				3										
CHORANTHUS VITELLIUS									1	1							
PARACHORANTHUS MAGDALIA			1				1										
EUPHYES CORNELIUS		2	1														
EUPHYES SINGULARIS			1			2	2										
ASBOLUS CAPUCINUS	1		1	1													
AMBLYSCIRTES FOLIA				1													2
LERODEA EUFALA	1		1	1		1	1									1	1
CALPODES ETHLIUS	1	1	1			1	1		1	1	1	1	1	1	1	1	1
PANOQUINA PANOQUINOIDES	1	1	1		1	1	1	1	1	1				2	1	1	1
PANOQUINA OCOLA	1		1	1		1	1		1			1			1	1	1
PANOQUINA SYLVICOLA			1	1	1	2	2		2	1	1	1	1	1	1	1	1
PANOQUINA CORRUPTA			1	1													
PANOQUINA NERO			1	1			1		2	2		2					
PANOQUINA FUSINA						1									3	3	3
NYCTELIUS NYCTELIUS			1			1	1	1	1	1		2	2	1	1	1	1
SALIANA LONGIROSTRIS			1												1	1	1
TOTAL 285 SPECIES																	

LITERATURE CITED

BALLOU, H. A. 1913. Notes on Insect Pests in Antigua. *Bull. Ent. Research* 4:61-65.

BARCANT, M. 1970. Butterflies of Trinidad and Tobago. Collins, London. 314 pp.

BATES, M. 1939. Notes on butterflies from Hispaniola. *Psyche* 46:43-51.

BROWN, F. M. 1931. A revision of the genus *Aphrissa. Amer. Museum Novitates* no. 454, 14 pp, 15 figs.

BROWN, F. M. 1933. Notes on *Phoebis* and a new species. *Amer. Museum Novitates* no. 653, 5 pp., 6 figs.

BROWN, F. M., and B. HEINEMAN, in press. Butterflies of Jamaica.

BUTLER, A. G. 1901. On some butterflies from St. Lucia, West Indies, coll. by Major A. H. Cowie. *Proc. Zool. Soc. London* p. 711-714.

CARPENTER, G. D. H., and C. B. LEWIS. 1943. A collection of Lepidoptera (Rhopalocera) from the Cayman Islands. *Ann. Carnegie Museum* 29:371-396.

CLARK, A. H. 1904. Notes on Insects of Barbados, St. Vincent, the Grenadines, and Grenada. *Psyche* 11:114-117.

CLENCH, H. K. 1942. The Lycaenidae of the Bahama Islands. *Psyche* 49: 52-60.

CLENCH, H. K. 1964. A synopsis of the West Indian Lycaenidae, with remarks on their zoogeography. *Journ. Res. Lepid.* 2:247-270.

COMSTOCK, W. P. 1961. Butterflies of the American Tropics: the genus *Anaea.* New York, American Museum of Natural History. 214 pp.

DYAR, H. G. 1914. Lepidoptera of the Yale-Dominican expedition of 1913. *Proc. U.S. Nat. Museum* 47:423-426

EMSLEY, M. 1963. A morphological study of imagine Heliconiini with a consideration of the evolutionary relationships within the group. *Zoologica* 48:85-130.

EMSLEY, M. 1965. Speciation in *Heliconius;* morphology and geographic distribution. *Zoologica* 50:191-254.

EVANS, W. H. 1951-1955. A catalogue of the American Hesperiidae. *British Museum Nat. Hist.,* London. 4 parts, 1015 pp.

FORBES, W. T. M. 1941. The Lepidoptera of the Dry Tortugas. *Psyche* 48:147-148.

FOX, R. M. 1956. A monograph of the Ithomiidae. Part I. *Bull. Amer. Mus. Nat. Hist.* 111:1-76. 1960, Part II. *Trans. Amer. Ent. Soc.* 86:109-171. 1967, Part III. *Amer. Ent. Soc. Mem.* 22:1-200.

FOX, R. M. 1964. Affinities and Distribution of Antillean Ithomiidae. *J. Res. Lepid.* 2:173-184.

FULDA, O. 1931. Sammeln in Haiti. *Ent. Rundschau* (Stuttgart), 48: 169-170, 176-179, 194-196.

GILLHAM, N. W. 1957. Subspecies versus geographic variation in Caribbean populations of *Anartia jatrophae. Amer. Museum Novitates* 1845: 1-22.

GODMAN, F. D. and O. SALVIN. 1884. A list of the Rhopalocera collected by Mr. G. French Angas in the island of Dominica. *Proc. Zool. Soc. London* pp. 314-320.

GODMAN, F. D. and O. SALVIN, 1896. On the butterflies of St. Vincent, Grenada, and the adjoining islands of the West Indies. *Proc. Zool. Soc. London,* pp. 513-520.

HALL, A. 1925. List of the butterflies of Hispaniola. *Entomologist* 58: 161-165, 171-174, 186-190.

KAYE, W. J. 1926. The butterflies of Jamaica. *Trans. Ent. Soc. London,* year 1925, pp. 455-504

KAYE, W. J. 1927. A catalogue of the Trinidad Lepidoptera Rhopalocera. *Mem. Dept. Agric. Trinidad and Tobago* 3:144 pp.

KAYE, W. J. 1940. Additions and corrections to the recorded species of Trinidad butterflies. *Trans. R. Ent. Soc.* 90:551-573.

KAYE, W. J. 1931. Additions and corrections to the author's "Butterflies of Jamaica." *Trans. Ent. Soc. London* 79:531-537.

KIMBALL, C. P. 1965. The Lepidoptera of Florida. *Fla. State Dept. Agric., Gainesville.* 363 pp.

LATHY, P. I. 1904. A contribution towards the knowledge of the Lepidoptera-Rhopalocera of Dominica, B.W.I. *Proc. Zool. Soc. London,* pp. 450-454.

LEWIS, C. B. 1947. Butterfly Notes. *Nat. Hist. Notes Nat. Hist. Soc. Jamaica,* 29-30:91; 31:111; 33:157; 35-36:204; 37:13; 49:8.

LINDSEY, A. W. 1926. Lepidoptera collected by the Barbados-Antigua expedition from the University of Iowa. *Univ. Iowa Studies Nat. History,* 11(7): pp. 33-35 in no. 7.

MILLER, L. D. 1965. A review of the West Indies "*Choranthus.*" *J. Res. Lepid.* 4:259-274.

MUNROE, E. G. 1951. The genus *Junonia* in the West Indies. *Amer. Museum Novitates* 1498:1-16.

MUNROE, E. G. 1949. Some remarks on the *orithya*-group of the genus *Junonia. Entomologist* 82:157-158.

MUNROE, E. G. 1957. Comparison of closely related faunas. *Science* 126:437-439.

SEITZ, A. 1924. The Macrolepidoptera of the World. Vol. 5. American Rhopalocera. Alfred Kernen, Stuttgart, 1139 pp.

SHARPE, E. M. B. 1898. On a collection of Lepidopterous insects from San Domingo, with field notes by the collector, Dr. Cuthbert Christy. *Proc. Zool. Soc. London* pp. 362-369.

RINDGE, F. H. 1955. The butterflies of the Van-Voast American Museum Natural History Expedition to the Bahama Islands, B.W.I. *Amer. Museum Novitates* no. 1715:1-20.

RINDGE, F. B. 1952. The buterflies of the Bahama Islands, B.W.I. *Amer. Museum Novitates* no. 1563:1-18.

SHELDON, W. G. 1936. Tobago and its butterflies. *Entomologist* 69:200-208.

STONER, D. 1919. Collecting terrestial arthropods in Barbados and Antigua, B.W.I. *Canad. Ent.* 51:173-178, 217-220.

TALBOT, G. 1943. Revisional notes on the genus *Danaus*. *Trans. Royal Ent. Soc. London.*

TORRE Y CALLEJAS, S. L. DE LA. 1954. An annotated list of the butterflies and skippers of Cuba. *Journ. N.Y. Ent. Soc.* 62:1-25, 113-128, 189-192, 207-249.

TORRE Y CALLEJAS, S. L. DE LA. 1963. Sobre la identidad de *Pieris menciae*. *Actas y Trabajos del Primer Congresso Sudamericano de Zool.* 3:

TUCKER, R. W. E. 1952. The insects of Barbados. *Journ. Agric. Univ. Puerto Rico,* 36:330-363, 352-353.

VEASE, and R. F. D'ALMEIDA. 1939. Revisao do genero *Appias* (subgen. *Glutophrissa*). *Bol. Biol.* 4(1):51.

WATSON, F. E. 1938. A new *Eurema* from Puerto Rico. *Amer. Museum* Novitates no. 971:1-2.

WILLIAMS, C. B. 1930. The migration of butterflies. Oliver & Boyd, London. 473 pp.

WILLIAMS, R. C. Jr. 1931. Cuban Hesperiidae. *Trans. Amer. Ent. Soc.* 57:305-318.

WOLCOTT, G. N. 1948. The insects of Puerto Rico, Lepidoptera. *Journ. Agric. Univ. Puerto Rico* 32:537-573.

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distriuational records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W.J. Reinthal and J.T. Mithell. Send data to Dr. W.J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U.S.A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P.O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P.O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W.T.M. Forbes. Entomological Reprint Specialists. P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B.M. Endicott. Distributed in U.S.A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P.O. Box 433, New York, N.Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A.I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

Centurie de Lepidopteres de L'ile De Cuba. P.H. Poey, 1832. C.W. Classey, 353 Hanworth Road, Hampton, Middlesex, U.K. in the U.S.A. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 9 *Number 4* *December, 1970*

IN THIS ISSUE

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Established in 1962

Edited by WILLIAM HOVANITZ

Volume 10

1971 (1973)

Published by
THE LEPIDOPTERA RESEARCH FOUNDATION, INC.
1160 W. Orange Grove Ave.
Arcadia, California, U.S.A. 91006

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

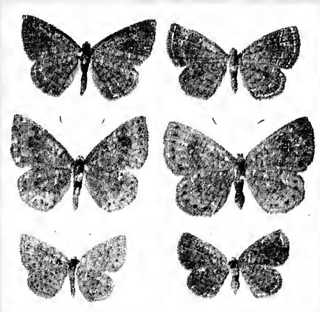
CONTENTS

Volume 10 *Number 1* *March, 1971*

Volume 10 *Number 2* *June, 1971 (1972)*

Volume 10 *Number 3* *September 1971 (1973)*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA



Volume 10 *Number 1* *March, 1971*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10 year
Family	15 year
Contributing	25 year
Subscribing	50 year
Sponsor	100 year
Life	250 for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

THE BUTTERFLY GENUS CALEPHELIS

FRONTISPIECE

WILBUR S. McALPINE

A REVISION OF
THE BUTTERFLY GENUS
CALEPHELIS
(RIODINIDAE)

WILBUR S. McALPINE

THE LEPIDOPTERA RESEARCH FOUNDATION, INC.
The Journal of Research on the Lepidoptera
1160 W. ORANGE GROVE AVENUE
ARCADIA, CALIFORNIA, USA 91006

THE LEPIDOPTERA RESEARCH FOUNDATION, INC.
The Journal of Research on the Lepidoptera
1160 W. ORANGE GROVE AVENUE
ARCADIA, CALIFORNIA, USA 91006

FOREWORD

This work on the genus *CALEPHELIS* is the result of nearly a lifetime of effort. Many of us were not yet born when Wilbur S. McAlpine collected that specimen shown in the color plate dated Aug. 1, 1915 (fig. 6). Mr. McAlpine is an amateur lepidopterist; by that is meant that his primary livlihood was in a field other than the study of Lepidoptera. Few indeed can truly claim to be "professionals". In the Lepidoptera, as in the study of most insect groups, it is the amateur 'professional' to whom we owe most of our knowledge. The key to this success is due not to monetary pursuits, but rather the pursuit of an intangible desire to make known what is unknown and to present these facts in as accurate and scientific a manner possible. We all realize that any one of our efforts is incomplete, and that some of our conclusions may be changed in the future, but we can be assured that there is here in this publication the greatest effort to present a job well done as a foundation upon which further steps upward may be made in the future.

The appearance of Calephelis is not that of an impressive butterfly, of bright colors. On the contrary, *Calephelis* is a very demure butterfly, the species of which may not differ by many (or any) visible wing characters. In this work, therefore, the more hidden structural details have been used as an aid in their distinction.

I first met Wilbur S. McAlpine in Michigan in 1945. He became one of the first subscribers to this Journal when it began publication in 1962 and he has been a contributing member of the Lepidoptera Research Foundation, Inc. from its organization to the present day. His devotion to the advancement of knowledge of the Lepidoptera speaks for itself.

W. Hovanitz

THE AUTHOR

WILBUR S. McALPINE

2501 Bogie Lake Rd., Rt. 3, Union Lake, Mich. 48085

Born: Detroit, Michigan, Dec. 30, 1888.

Education: Graduate of Detroit Central High School, Jan. 1908.

Service: 472nd Engineers, First World War 1918.

Family: Wife and son.

Positions: U.S. Lake Survey 1908, 1909, M.C.R.R. draftsman 1910, 1912, Detroit Edison Co. draftsman 1914, Assistant Surveyor in Survey of Coal Claims at Homer, Alaska 1906, 1907, 1911, Principal and owner of a Mapping, Surveying and Engineering business at Birmingham, Mich. under name of McAlpine Engineers Inc. and W. S. McAlpine Map Co. from Dec. 1915 to Jan. 1, 1965 when I retired and sold the business to my employees who are at present conducting the business under the same names.

During my ownership of the business complete maps of all counties of Michigan were made showing sections, also a property ownership Atlas of Oakland County, Mich., and detailed sectional maps of several townships in Oakland Co. Surveys made during this period included over two hundred Subdivision Plats, engineered and recorded, also numerous farm, topographic and lot surveys.

In 1914, 1915 and 1916 I made collecting trips for Lepidoptera to various localities in Michigan for the University of Michigan Museum and have done considerable collecting of Lepidoptera for myself in Michigan ever since about 1905 when I first became interested, and have a private collection of at least 10,000 insect specimens, mostly Lepidoptera, from Michigan.

Interests: Collection and study of Michigan Lepidoptera, life history work in particular. Have been much interested in *Hyalophora columbia* in Michigan, and have reared it, and its hybrid with *H. cecropia.*

(Continued on page 8)

TABLE OF

CONTENTS AND ILLUSTRATIONS

THE AUTHOR

WILBUR S. McALPINE

(Continued from page 6)

Recreation: Collection of Lepidoptera and in late years Calephelis in particular, traveling by motor car with wife in United States and Mexico, and making two trips to Europe visiting British and Paris Museums.

Evangelistic singing, as soloist.

Papers: Publication of life histories of two Michigan butterflies and naming of two new species of Calephelis over thirty years ago.

Honors: Life Member of Oakland Co. Engineering Society 1969, Life Member Michigan Society of Registered Land Surveyors 1970, Honorary Member of Michigan Entomological Society, 1970.

Journal of Research on the Lepidoptera 10(1):1-125, 1971

A REVISION OF THE BUTTERFLY GENUS CALEPHELIS (RIODINIDAE)

WILBUR S. McALPINE

2501 Bogie Lake Rd., Union Lake, Michigan

INTRODUCTION

I FIRST BECAME PARTICULARLY INTERESTED in the genus Calephelis when I discovered that the little metal mark we were finding in Michigan was not *Calephelis borealis* but a new species which I described in 1937 as *Calephelis muticum.* This was brought about through working out its life history and comparing same with the life history of true *Calephelis borealis* which Cyril F. dos Passos was making at that time. Determinations were made at the U. S. National Museum, and I found then that much confusion existed regarding identity of species in that genus. A little later my friend Dr. George W. Rawson, who had collected Lepidoptera extensively in Michigan, sent me a few specimens of a Calephelis that he had collected at San Antonio, Texas in 1919. These specimens also proved to be a new species, so I described it in 1939 as *Calephelis rawsoni.* I then decided to obtain as much Calephelis material together from all sources, that is museums in this country and Europe and private collectors and make a Revision of this genus. At first I expected to only make a Revision of species in United States and Mexico but considerable material kept coming in from Central America and South America so I decided to make a complete Revision of genus Calephelis as it occurs throughout the Americas. Besides making several trips to Texas, Arizona, California and Florida in search of specimens, I have also made a couple of trips to Mexico for specimens and a couple of trips to Europe, examining specimens in the British Museum and Paris Museum.

The authors of the generic name Calephelis were Grote and Robinson, published in Trans. of American Entomological Society, Vol. 2, Page 310, in 1869, with type *Erycina virginiensis*

Guerin-Meneville 1831 and was based principally upon their genus having naked eyes, and not hirsute ones as in some tropical species of genus Charis. This generic name was recognized by all until 1922 when Barnes and Lindsey proposed the name Lephelisca to take the place of Calephelis because of an error made by Grote and Robinson in miss-identifying *C. virginiensis* their type specimen before them, as *Charis caenius,* a name it was listed under in lists at that time. Most lepidopterists including McDunnough in his check list of 1938 ignored the generic name Lephelisca but it was revived again in 1947. This whole matter was clarified however, by a unanimous decision of the International Commission on Zoological Nomenclature made in Feb. 1967 in which the name Calephelis was validated with type *virginiensis* Guerin-Menville 1831, and Lephelisca and other generic names in use were placed in the official Index of Rejected and Invalid Generic names. Dr. Cyril F. dos Passos, who made the application to the Commission to validate the name Calephelis, and the author of this paper, were largely instrumental in bringing this about.

The name Calephelis is derived from Greek words meaning "the beautiful deceiver" and from my experience and that of others trying to make identifications in this genus, it is certainly most appropriate. Only a dozen species of Calephelis have been described to date of this publication, and a couple of these have proved to be synonymous or unrecognizable.

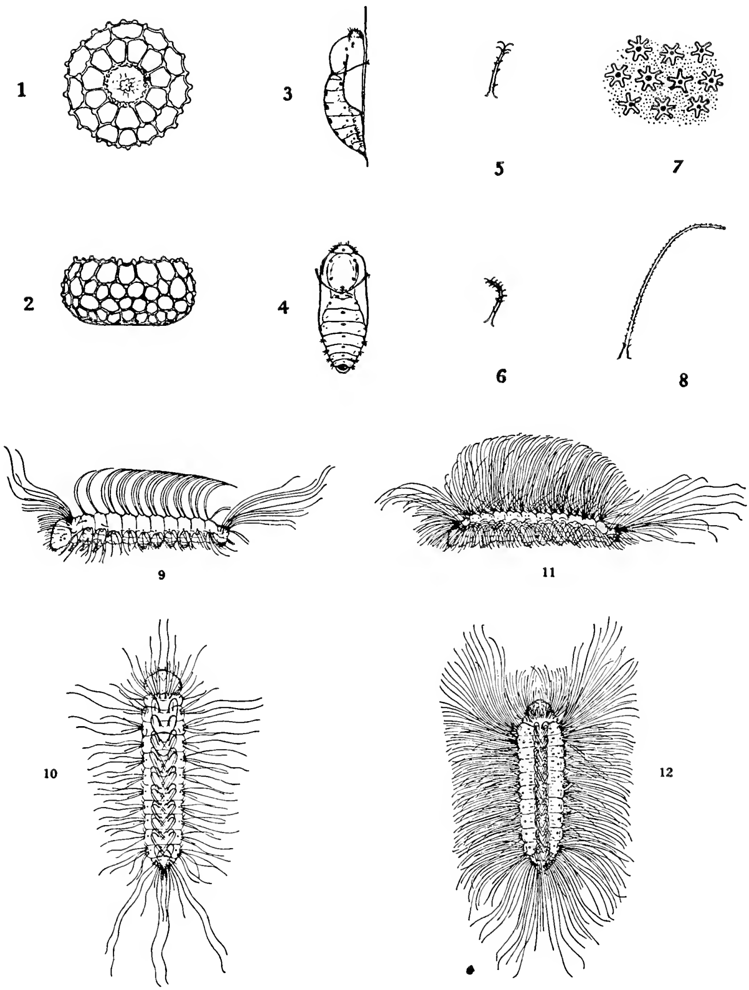
Calephelis is a genus of small butterflies, which have a wing expanse of about one inch. The upper wing surface is rather plainly colored with shades of brown, the basal half being darkened by a small black rather indistinct irregular linear markings which form broken concentric lines with the base. There are two marginal lines of rather faint metallic markings, usually silvery, which extend along outer margin of both wings between which is a row of small black dots. The lower wing surface is of a light ochre color, with markings of the upper wing surface repeated, only much more discernible and attractive, especially the metallic, silvery ones. They are weak flyers and often alight with their wings spread out on the under side of a leaf. In the warmer climates where most of the species occur, there are seasonal forms, and usually several broods, which adds to the difficulty of identification. Little is known regarding their life histories but from the few that are known, their food plant usually occurs in restricted areas near streams or in swamps, so the butterfly is not commonly seen, and is among the rarer

butterflies in the usual collection. Only the complete life histories of *borealis, muticum* and *nemesis, sub-species californica,* have been described agreeing in all three species as follows: egg turban shaped, caterpillar has long white hairs extending out laterally and up mid-dorsally; the chrysalis is suspended by a girdle of silk at the middle, and is covered with the molted exuviae and hairs of the last larval molt having the appearance of a loose woven cocoon. All the species look very much alike and are difficult to identfy with certainty, except through genitalie examination. The genitalia of both male and female usually have fairly good characters but some run close together in the complex species, especially in the males. The general pattern of Calephelis genitalia is distinctive from other Riodinid genera. In my drawings of genitalia in this Revision every effort has been made to make detailed accurate drawings, which speak for themselves much better than lengthy descriptions.

The range of the genus is approximately from the southern border of Canada, through Central America and through Argentine in South America with center of distribution appearing to be about Guatemala in Central America. Most of the species of this genus occur in the tropical areas below the United States border.

When one considers the size of a butterfly he usually thinks of its wing expanse, in inches or fractions, but in late years many authors, in order to be more exact, express size in millimeters, and by length of the forewing. In the genus Calephelis all the species are small, and of about the same size, being about three quarters of an inch (or nineteen millimeters), to an inch (or twenty-five millimeters) in wing expanse, and exact size is not very important. Even within the species there is some variation in size, due to food supply in their caterpillar stages. In my descriptions I have expressed size in millimeters for wing expanse, it being the measurement betweent the tips of the primary wings, the butterfly being mounted with posterior edge of primary wings at right angles with the abdomen which is the usual way for mounting in museum collections, and have also indicated the length of the forewing in millimeters.

In my illustrations in the Revision, the upper and lower surfaces of the butterfly are shown by photograph, but as all the butterflies in this genus look very much alike, they cannot usually be identified by superficial examination. The most positive means of identification of the various species is through examination of their genitalia, both male and female, where constant structural



1 and **2.** Egg, size horizontal 0.6mm.; **3** and **4.** Chrysalis length 9mm.; **5.** Substigmantal bristle on chrysalis greatly enlarged; **6.** Head bristle on chrysalis greatly enlarged; **7.** Sprocket shaped processes greatly enlarged; **8.** Typical long dorsal hair greatly enlarged; **9** and **10.** Larva First Instar length 1.3mm.; **11.** Larva Sixth Instar length 5.8mm.; **12.** Larva Fourth Instar length 3.4mm.

Drawings by W. S. McAlpine

Early stages of *Calephelis muticum* McA.

Figure 1.

Reprinted from: *Bull. Brooklyn Ent. Soc.* 33:111-121. 1938.

differences usually occur. There may be some variation in genitalia of some of the species or sub-species described, but the male genitalia is more constant while the female genitalia appears to be quite variable in a few of the species. Life history work is necessary to more fully determine this. Drawings were also made of some of the parts of the genitalia that were not so important for identification, but may be of some value. Drawings of the wings of most of the species were made, although the wing venation is practically the same, but the wing shape varies, being fairly constant in the various species.

There has been some confusion in the listing of Calephelis species. Carlos C. Hoffman in his Catalogue of Mexican Butterflies (1940) lists *velutina* and *craspidiodonta* under Calephelis. *Charis velutina* and *iris* has also been listed under Calephelis in Lepidopterorum Catalogus Vol. 38, 40, 41, 44 (Riodiniidae) by H. Stichel under the group or sub-generic name Iridiformes. Formerly *Charis iris* was listed by (Staudinger) under Calephelis in 1876 and also by Godman and Salvin Trans. of Ent. Soc. London 1880 and also by Godman and Salvin in Proc. Zool. Soc. of London in 1878. The above mentioned species are all hairy eyed, and they also do not look superficially like Calephelis, especially on the lower wing surface, and their genitalia is also quite different. However, the wing venation of the above species is quite similar to that of Calephelis. In the Revision I have shown photos of *Charis iris* and *Charis velutina* as well as drawings of male and female genitalia and wing venation, of these two species, for comparison with Calephelis.

For convenience in this Revision I have numbered the various species and their sub-species, this numbering beginning with the known recorded species, in order of their recording. However, due to lateness in getting the complete Revision to the printer, photo No. 11B ♀ abberation of *C. perditalis* and photo No. 18 ♀ allotype of *C. dreisbachi* are placed at the end of photos, after No. 39. In this Revision there is one colored plate showing three species of Calephelis, upper and lower surfaces, which is quite typical of coloration of all the Calephelis species. Throughout the Revision initials are sometimes used for the following Museums: U.S.N.M. = U.S. National Museum; B.M. = British Museum; A.M. = American Museum; C.M. = Carnegie Museum. In many places in the Revision the Calephelis species and sub-species, whether formerly published or new, are referred to only by their specific or sub-specific name.

In this Revision I have shown basic location maps of North and South America, indicating the countries and some divisions of same, but have not attempted to locate by symbol the various species and sub-species, as I feel it would only be confusing, as some of the species are concentrated in approximately the same location and the range of the species is clearly indicated in the descriptions. I have endeavored to publish everything by way of drawing and writing that I have learned about this genus.

Acknowledgements — I have received full cooperation from all of the museums in the United States and Europe and from many collectors, whenever I requested the same. Among the museums in the United States, the U.S. National Museum, Carnegie, American, Los Angeles County Museum, University of Arizona, University of Michigan, Michigan State University and Museums in Europe, the British Museum, Berlin Museum and Paris Museum. Among Lepidopterists and collectors are Dr. Geo. W. Rawson, H. A. Freeman, Cyril F. dos Passos, J.F.G. Clark, E. C. Welling, Dr. C. L. Remington, Dr. John A. Comstock, Dr. A. E. Brower, Don B. Stallings, Roy O. Kendall and wife, M. A. Richard, Dr. J. W. Tilden, Fred T. Thorne, C. M. Dammers (desc.), Lloyd Martin, Killian Roever, R. J. Jae, Bryant Mather, Ralph L. Chermock, Dr. Lee D. Miller, Dr. W. H. Wagner, J. F. Donohue, G. N. Ross, R. J. Wind, Otto Buckholz, Albert Pinkus, W. W. Newcomb (desc.), R. R. Dreisbach, (desc.), Dr. Tarsicio Escalante, Dr. Salvador L. de la Torre, Geo. P. Englehardt (desc.), and also G. E. Tite and N. H. Bennett of the British Museum. Harry K. Clench, F. Martin Brown and William Field have given me much assistance and have checked or read over the manuscript before publication. I am very grateful to all the above mentioned Museums and individuals and any others I have failed to mention, for their assistance and forbearance with me in this work.

PREPARATION OF GENITALIA AND WING VENATION SLIDES.

In the genus Calephelis all the species look so much alike that it is usually impossible to identify them by superficial examination, but fortunately in most of the species, the genitalia of both male and female show some constant structural differences and examination of the genitalia is the only positive means of identification.

The making of genitalia slides becomes necessary and the following method is suggested, most of which was outlined by

J. F. Gates Clark of the U. S. National Museum. Remove the abdomen of the mounted specimen by a quick downward thrust on the ventral side of the abdomen. Soak the abdomen in 10% K.O.H. overnight. Dissect out in water (using a syracuse watch glass, inside diameter 50 m. m.) carefully removing all foreign matter, remains of masculation and membrane. Most of the scales may be removed from the abdomen by the gentle application of a small camels hair brush and use of a couple of needles. The removal of the scales will at the same time force most of the undesirable material out of the abdomen. Remove parts to a second wash of water cleaning up and spreading (where possible) the valvae or harps. Then introduce 95% alcohol (in a watch glass) where the cleaning is finished (all remaining scales should come off in the alcohol). The genitalia will harden in the alcohol and should be held in the position desired for slide while in this wash and until they are firmly set. In some cases it is desirable to remove the aedeagus, and this can be done in the second wash of water but may be done in the alcohol. Allow parts to harden thoroughly in the alcohol (15 min. to one hour) and remove to clove oil (in a watch glass) to harden and clear. Avoid using the clove oil more than once or twice since it will become too diluted with alcohol and will be less effective. The genitalia should be allowed to remain in the clove oil until clear and hard, usually from fifteen minutes to a half hour will be required. Finally introduce into xylol (xylene) and wash out excess oil. Mount in balsam or permount (a registered trade mark of Fisher Scientific Co.) preferably the former (which is neutral in xylol), on a microscope slide depressed somewhat in the middle, and label carefully so that the slide and butterfly from which it was made may be easily associated by any one. A flat microscope slide can be used instead of one depressed in the middle, for the permanent balsam mount, and a thin round cardboard or plastic riser (outside diameter same as cover glass) can be used to retain the balsam, and which I believe allows for better placing and examination of the genitalia.

I find that the use of glycerine instead of balsam or anything else in the preparation of genitalia for quick study is very convenient. After the xylene wash as outlined above, the genitalia can be transferred to a flat microscope slide with four or five drops of glycerine and without using a cover glass. Dissection of the genitalia can be made then instead of in the water baths and drawings also can be made. This type of temporary slide will last for a considerable time without the glycerine drying up and

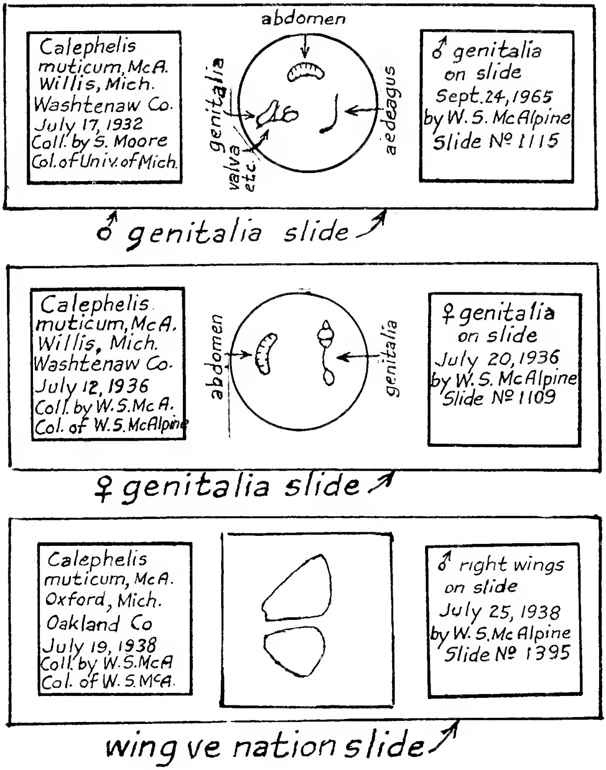


Figure 2.

Proposed genitalia slides

during this time the genitalia can be transferred to a permanent mount using balsam and round cover glass. If further time is needed to prepare a permanent slide the genitalia can be transferred to a small vial in some glycerine and can be kept there indefinitely.

In preparation of wing venation slides the following method is used. Remove the two right hand wings carefully from the butterfly so as not to break any parts adjacent to the abdomen. Dip the wings in alcohol to wet them. Then put them in standard solution of clorox (commercial sodium hypochlorite solution) and leave them there until color has been removed which is usually about ten minutes with Calephelis specimens. One must be careful not to over bleach them or the venation becomes difficult to see. After the wing is bleached out, put it in alcohol and leave it there until it floats. This is to remove the clorox solution and stop the bleaching action as well as driving out the water. Then place the wings, upper side up, on a thin coating of glycerine about three quarters of an inch wide across a flat microscope slide, arranging the wings in a natural position as shown in my illustration. A small camels hair brush can be used to advantage to place the wings in position and prevent folding. The glycerine will spread over the wings, and then a square cover glass can be placed over same and excess glycerne carefully pressed out, but not so much as to displace the wings. If too much glycerine is used there will be slippage of the cover glass. This type of wing venation slide can become permanent, but care must be taken in using same until the glycerine dries up around the edges of the cover glass. Possibly a more permanent wing venation slide can be made by using balsam or something else, as described previously, still I have found it impossible to make the wing venation slides with anything else except glycerine, with such small butterflies as Calephelis.

In the making of microscope genitalia and wing venation slides the following list of equipment is necessary; a compound microscope with wide range of magnification (from five to forty times) and having two eye lenses, the right hand lens showing a division of 196 squares, with fifteen lines on each side, and every other line being numbered from 0 to 7. This lens showing squares is very necessary for making accurate drawings, on the cross section paper; a small hand lens with magnification five or six times; slender pointed forceps or tweezers; small scapel (flat at end and slender pointed); dissecting needles 55 mm. in length; several syracuse watch glasses (inside diameter 50 mm.); several

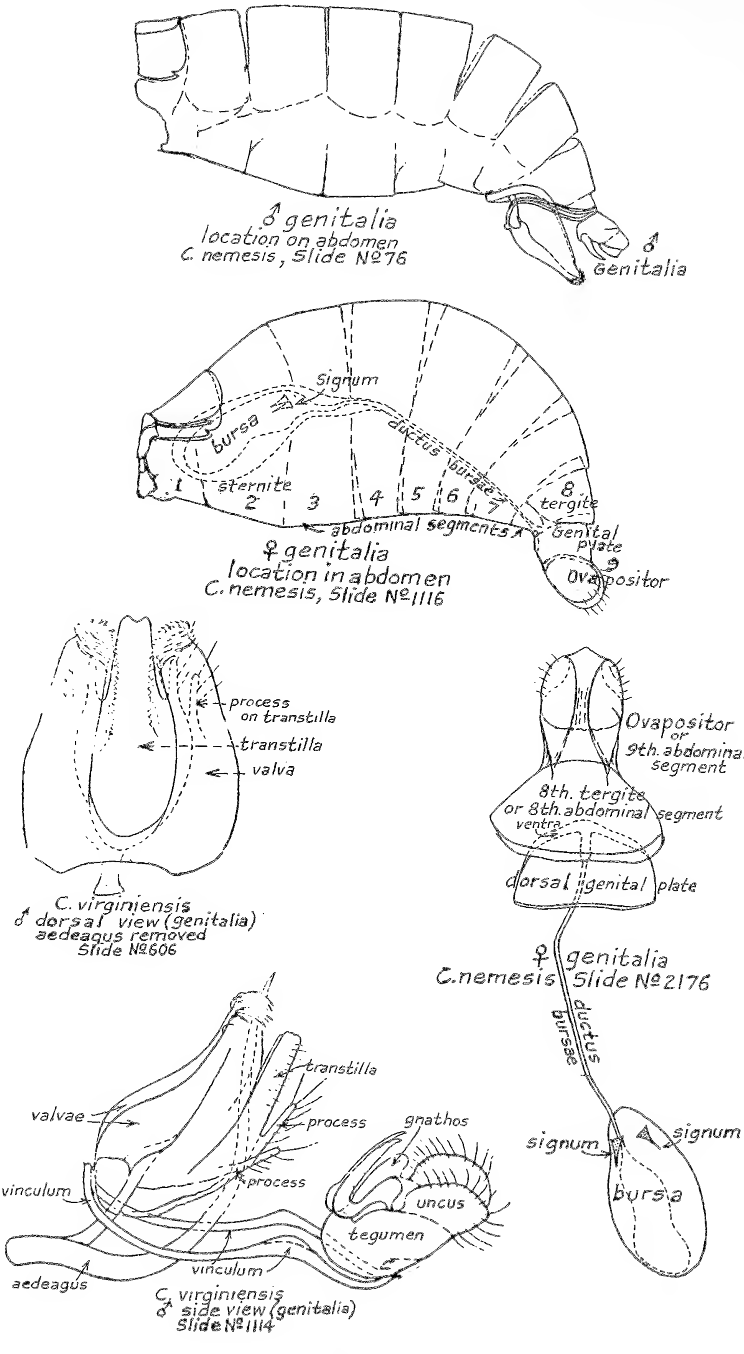


Figure 3.

Location and names of parts of genitalia.

small two inch vials; medicine dropper; shears; fine camels hair brush; small pocket knife; metal scale 6inch by 5/8 inch with 1/16 in. divisions and millimeter divisions; microscope slides 75 mm. by 25 mm.; cover slips (round 20 mm.); cover slips square (22 mm. x 22 mm.); No. 290 gillott pen points; slide labels 24 mm. x 24mm.; cross section transparent sheets with 1/8 inch squares; india ink.

A list of reagents needed is as follows: alcohol 95% solution; clorox (standard); K.O.H. 10% solution; Canada balsam; xylol (xylene) and clove oil.

There are several papers which have been published giving instructions for making genitalia and wing venation microscope slides among which are ones by J. F. Gates Clarke; Harry Clench with L. D. Miller; and J. H. Comstock; as follows:

"The Preparation of Slides of the genitalia of Lepidoptera" by J. F. Gates Clarke, Bull. Brooklyn Ent. Soc. 36:149-161, 1941.

"How to prepare slides of sclerotized parts of Lepidoptera" by Harry K. Clench and Lee D. Miller; Typed separate, issued by Carnegie Museum, Pittsburgh, Pa. 15213, Section of Insects and Spiders.

"Outline of Laboratory work in the Study of the Venation of the Wings of Insects" by John Henry Comstock, The Comstock Publishing Company, Ithaca, New York, 1918. Reprinted from "The Wings of Insects."

All the original drawings of genitalia and wing venation in this Calephelis Revision were made by the author, the genitalia being enlarged about forty times and the wings being enlarged about five times by using the 1/8 inch squares. The drawings are first made using a 3h pencil and later inked in with india ink, using a 290 gillot pen, for final photographing. In my final published drawings in this Revision the genitalia are enlarged about twenty times and the wing venation drawings are life size.

In the course of my work with the genus Calephelis I have made more than 2000 genitalia slides and preparations.

Figure 4.

North America showing boundaries of countries and locations referred to in text.

Figure 5.

South America showing boundaries of countries and locations referred to in text.

No. 1 **Calephelis virginiensis** Gray, 1832

Described in Griffith The Animal Kingdom Addn. Vol. 15, p. 58, Fig. 1a (1832) under name Erycina virginiensis, type in British Museum.

Syn. *Nymphidia pumila* Boisduval & Leconte, described in Hist. Lepid. Amer. Sept. Vol. 1, pp. 131 to 137, Figs. 6, 7 (1833) Type in U.S. National Museum.

Syn. *Calephelis louisiana* Holland, described in Entomological News, Jan. 1929, p. 20, Recorded as a Synonyn in Bulletin of Brooklyn Ento. Soc. Apr. 1937 by W. S. McAlpine. Type in Carnegie Museum.

One of our smallest species the male from 19-22 mm. in wing expanse, forewing 10 or 11 mm. Upper wing surface is of a uniform, rather bright light reddish brown with small blackish markings on basal half. As usual in this genus there are two marginal lines of metallic or silvery markings across both fore and hind wings, the inner line being more irregular and exserted at center of fore wing, while the outer line is straight and near the edge of wings. Between these metallic lines is a row of small dark spots. The metallic lines are not very distinct on the upper surface. There is no median dark band or shade across both wings as in borealis and some other Calephelis species. The lower wing surface is of a light tawny or ochre color with markings of the upper surface repeated, but much more prominent especially the silvery metallic lines, due to the lighter ground color. The fringes of the wings are light brown and not checkered.

This butterfly is similar in markings and color to muticum, but is smaller. The wing shape of fore wing of virginiensis in both sexes is rounded and quite similar, more so than in *muticum, virginiensis* is also somewhat similar to *perditalis* in both size and similarity of the sexes. The male genitalia differ distinctly from those of the other species, but the female genitalia are quite similar to those of *C. muticum.*

The life history of *virginiensis* has not been described, but Mr. M. A. Rickard of Houston, Texas has done some unpublished work on it, having found it near Houston, and reports its food plant is thistle. There is also an old record of its occurrence at Black Jack Springs, Texas. The type locality is Georgia, U.S.A. The male type by Gray and a series of four males and one female, all labeled Georgia, are in the B.M. The range of the species is the southern and southeastern United States, north to Virginia and Ohio, south to Southern Florida and west along gulf states to Louisiana and southeastern Texas to Houston.

No. 2 **Calephelis nilus** Felder (Moritz in litt) 1861

A doubtful species or "Species Inquirenda". Described as *Charis nilus* by Felder in "Wiener Ent. Monatschr" No. 4, April 1961, p. 100.

The original description in German is brief and very general, the type was described as a female, but later it proved to be a male.

The type in the B.M. is labeled as follows. A small circular hand-written label "Venezuela Moritz type"; a rectangular hand-written label *Charis nilus* Feld and a characteristic Felder label in brown backing *nilus* M.

There is a second specimen, in the British Museum, assumed to be in the original *nilus* type series, its abdomen is missing and the left hind wing almost entirely gone. On it a small circular label, "Venezuela Moritz". This specimen is somewhat larger than the male type but appears to be quite similar to the type in general appearance. Because the abdomen is missing it is impossible to even determine the sex.

The following is a brief description of type *nilus*. Primary wing expanse 20 mm., forewing 10 mm. There is no head on the type but it is a fairly good specimen with fringes worn but light brown in color, with some slight white checkering noticeable particularly on the lower wing surface. Color of upper wing surface chocolate brown, with basal half darkest, caused by the ill defined black markings which form about four irregular broken lines concentric wth the base, the outer of these lines being more discernible.

There are two outer lines of small metallic markings, which are somewhat leaden in color and not very prominent, between which is a row of rather prominent black dots. The lower wing surface is of a uniform light tawny color, slightly reddish, with all markings of the upper surface repeated and well defined, the metallic markings silvery. The outer basal line of black markings is single and not doubled as in the type of *perditalis*, but this doubling is not always true in other specimens of *perditalis* which I have examined. The wing shape of the male type of *nilus* is somewhat rounded as is usual in female Calephelis, so it is easy to understand how it could be mistaken for a female. As shown in the figures. It is more like that of *virginiensis* than either *perditalis* or *incaensis,* a new species which is found in Venezuela and adjoining areas.

The genitalia of the male type of nilus were very badly damaged when I last examined them in 1968, but when I first examined them in 1952 a couple of years after the genitalia slide was made, the genitalia appeared somewhat damaged with

transtilla split through the middle and spread out, but they still looked most like those of perditalis and not like the genitalia of any other specimens I had examined from Venezuela. It does not seem possible that type *perditalis* could be a synonym of *nilus* because of the great distance between type localities. *C. perditalis* being from Texas.

After examining the type of *nilus* in 1968 and its very badly damaged genitalia I have come to the conclusion that *C. nilus* is a very dubious species. It is impossible now to reconstruct an accurate drawing of the original genitalia, which are a principal means of identification of species in genus Calephelis.

No. 3 **Calephelis argyrodines** Bates 1866

Charis argyrodines H. W. Bates, Dec. 1866 "Entomologists Monthly Magazine", 3:154.

Calephelis argyrodines is one of the larger Calephelis averaging about 25 mm. in primary wing expanse. The male type is in the British Museum and is a badly battered and worn specimen, with upper surface a rather uniform chocolate brown in color with slightly darker basal half and indication of a median darker patch in primaries. The two marginal lines of metallic markings are barely discernible and the black dots between are only partly discernable. The whole upper surface is not a smooth brown, but inclined to be spotty. There is no noticeable white checkering of the fringes that remain, and they are mostly worn off. The lower surface of type is not worn so much and is of a rather light reddish brown or tawny color. Both silvery and black markings are readily discernible.

The original description of *Charis argyrodines* is as follows: "♂ Exp. 10"12". Closely allied to the North American *Ch. ceneus* Lin. (*virginiensis*. Bois. et Leconte) agreeing with it in color both above and beneath, but differing in the forewing being much more elongate and pointed. Above, obscure dark brown crossed by numerous short fine dark streaks, which are generally connected together as fine wavy lines, towards the outer margins is a row of small black spots, and there are two extremly fine and indistinct silvery lines, the inner one of which is strongly waved, the fringe is dark brown indistinctly spotted with ashy. Beneath tawny yellow, the fine black streaks and spots more distinct than on the upper surface, silvery lines much broader. Eyes naked. Guatemala also Nicaragua."

The male type has three original labels on designated as follows. A hand-written black edged rectangular label. "Type of *Charis argyrodines* Bates", a printed rectangular label, "Duenas Guatemala, F.D.G., & O.S.", a printed rectangular label, "B.C.A. Lep. Rhop., *Charis argyrodines* Bates, Godman-Salvin Coll. 1914-5", there is also an additional male genitalia slide label.

Because of the rather battered male type specimen and its

badly twisted genitalia on a slide made in 1947, which made it difficult to make an accurate drawing of same, I have assumed a male specimen from type locality Duenas Guatemala which is in the British Museum, to be a topotype, as it agrees well in size 25 mm. in primary wing expanse, forewing 13 mm. and in color and shape of wings with the male type, and it also agrees well with the original description. It has on it an identical printed label, "B. C. A. Lep. Rhop: *Charis argyodines* Bates Godman-Salvin 1914-5" as is on the original type specimen. I have also assumed a female specimen which is in the British Museum, from type locality Duenas, Guatemala, which has on it an identical printed label, "B. C. A. Lep. Rhop. Charis argyrodines Bates Godman-Salvin 1914-5" as is on the original type specimen, as a female of this species, it having a primary wing expanse of 26 mm., forewing 13 mm. The genitalia of both the male topotype and the assumed female are figured.

I have seen specimens that agree well both superficially and in genitalia with argyrodines but having a slight dark median irregular shade or band across both wings to a greater or less degree, which is not evident in the worn type. Also the fringes in some specimens of *C. argyrodines* are more checkered with whitish than in others. *C. argyrodines* looks very much like *C. costaricicola* Strand as reproduced in the topotype but there are some considerable differences in genitalia of both male and female as shown in drawings of same.

The male genitalia differs principally in shape of valvae which is slimmer and not rounded as in *costaricicola* and the end of the transtilla is also slimmer. The posterior edge of female genital plate is heavier than in costaricicola. In the original description and figures *costaricicola* is considerably smaller than argyrodines, but the type of *costaricicola* appears to be a rather dwarf specimen. I have a large series from Guatemala that are much larger and about the size of *argyrodines.*

No. 4 **Calephelis borealis,** Grote and Robinson, 1866

Nymphidia borealis, Grote and Robinson, 1866, Annals of New York Lyceum of Natural History, 8:351

Calephelis borealis is one of the larger species of this genus being 25-30 mm. in wing expanse, forewing 14 to 15 mm. The basal half of upper surface is of a dull brown chocolate color, upon which are small black markings which form four or more broken lines concentric to the base, the outer basal line being the outer edge of a suffused but rather prominent dark brown shade or band across the middle of both wings followed by a

submarginal area of a lighter reddish brown shade. The two silvery lines of metallic markings in this submarginal area are not very distinct, the inner one being heavier and waved while the outer line near edge of wing is straight and fine. Between the two silvery lines is a line of rather prominent black dots. The fringes are light brown and usually checkered with white at apex and inner angle of the primaries.

The lower surface is of a pale orange color with all markings of the upper wing surface repeated but much more prominent than on upper surface due to the lighter background. The genitalia characters of both male and female are good. Its life history was partially worked out by Cyril F. dos Passos and published Aug. 1936 in the Canadian Entomologist. The egg is turban shaped and the larvae is fringed with long white hairs as well as having two mid dorsal rows of similar long white hairs projecting upward. This species is single brooded, adults appearing in early July. There are nine caterpillar stages and it hybernates for the winter in the fourth stage. Its life history is quite similar to that of *C. muticum*. *C. borealis* occurs in open woods on higher ground usually near small streams where its food plant Senecio obovatus occurs.

The range of this species is Southern New England, south to Virginia and west through Indiana and to Missouri, by my records. Type locality is near Upper Coldenham, Orange Co., New York, about 9 miles west of Newburg on the Hudson. I have been unable to find out where the type or type series were deposited.

No. 5 **Calephelis nemesis** Edwards 1871

Charis nemesis, W. H. Edwards 1871, Transactions of American Entomological Society, 3:212.

This is one of our most complex species. It was described from one male specimen taken by Dr. Palmer in Arizona, with no exact location. F. Martin Brown has written a paper about Edwards types in Carnegie Museum which is very complete.

Edwards complete description is as follows in quotes.

"Male expanse one inch, upper side pale brown, the basal half a shade darker and limited on middle of both wings by a wavy outline. Underside pale fulvous, both wings crossed by two marginal lines of plumbagious point, a third line of black non-metallic points crosses the disks and a fourth is basal."

While Edwards' description seems to lack detail, still it appears to fit very well one male specimen in the Edwards collection labeled *nemesis* Arizona in Edwards' own handwriting, although there are some other specimens labeled nemesis by Edwards in his collection that agree in a general way. I have designated this

specimen, which is rather worn, as neotype, with identifying label, and it is possible that this specimen may be the original type specimen described by Edwards. Following Edwards' description he states this single male specimen was in the Department of Agriculture, which was later transferred to the U.S. National Museum, but there is no record of this specimen being there. I have another somewhat fresher specimen taken at Tucson, Arizona by the late George P. Englehardt on April 1, 1935, that fits the original *nemesis* description very well. It is quite possible that the Tucson area is the type locality of *C. nemesis,* as Dr. Palmer was known to have been there in the Fall of 1867 and 1869. This specimen is a possible topotype of *C. nemesis.* There is a female specimen from Picket Post Mt. north of Tucson which is a possible female of this species. The size of the possible male topotype primary wing expanse 22 mm. The size of the female above referred to is primary wing expanse 18mm. These two specimens with permission of original collectors will be deposited in the Carnegie Museum.

Having seen many specimens of Arizona *nemesis,* it appears that Edwards type *nemesis* is an extreme variant of that species, as the usual black dots between the marginal and sub-marginal metallic lines are missing or only just slightly discernible near anal angle of secondaries and Edwards does not mention these black dots in his description. A comparison and description of the average *C. nemesis* as compared with *C. nemesis australis* sub-species is given in my *C. nemesis australis* sub-species description in this Revision.

The life history of *C. nemesis* from Arizona has never been worked out to my knowledge.

In this publication I am naming four sub-species of *C. nemesis* as follows: *C. nemesis australis, C. nemesis californica, C. nemesis dammersi and C. nemesis bajaensis* based mostly upon slight constant genitalia differences and other fairly constant superficial differences from original type *nemesis.* Life history work is very desirable in the various sub-species of the complex species *C. nemesis* to further verify their status.

The range of *C. nemesis* and its various sub-species appears to be Texas, Arizona, California and adjoining areas including parts of northern Mexico.

No. 5A **Calephelis nemesis australis** Edwards (new status)

Charis australis W. H. Edwards November 1877 Field and Forest 3:87. Syn. *Charis guadeloupe.* Strecker March 1878 Lepidoptera, Rhopolaceres and Heteroceres: 131.

Edwards description of *Charis australis in* 1877 was much more

detailed that that of *Charis nemesis* in 1871. A condensed description of Edward's *Charis australis* is as follows: Male expanse of wing 0.9 inch, size and shape of *C. nemesis,* with primaries pointed at apex. Upper wing surface rather uniform reddish brown with basal half a shade darker due to four or five irregular convex lines of broken faint black markings, that extend across both primaries and secondaries, its outer margin being the outer convex irregular line. Usually on the inner side of this outer irregular line is a narrow irregular dark shade or band across both primaries and secondaries, this shade being broader near upper discal area of primaries. The usual two lines of marginal and sub-marginal metallic markings together with a well defined row of black dots between them, extend across both primaries and secondaries. These black dots being located nearer the outer marginal line of metallic markings. The outer marginal metallic line is fine and straight, near outer edge of wing, while the inner sub-marginal metallic line of markings is heavier and broken at the veins, and outwardly exserted near center of the wing, but not so much as in *C. virginiensis.* These metallic lines are just barely discernible on the upper wing surface. The lower wing surface is light fulvous and all markings of the upper surface are repeated, and are prominent due to light background, especially the two lines of metallic markings which are silvery.

The female is a little larger than the male with metallic markings heavier and more prominent on the lower wing surface and the shape of primaries are rounded and squared off at apex. Edwards received his type series of *C. australis,* which consisted of four males and three females from Jacob Boll, who collected them at San Antonio, Bexar Co., Texas. This type series of specimens in the Edwards collection at Carnegie Museum was first examined by me in Nov. 1937 and then consisted of three males and three female specimens which were all similarly labeled australis, in Edwards handwriting. Both males and females were quite constant respectively, with the exception of one male specimen which was illustrated by Holland 1898 in his Butterfly book, Plate 28, Fig. 14, as *C. nemesis* on his plate explanation, although in his text he referred to it as *C. australis.* Later, in Holland's 1931 edition, the same specimen was illustrated on Plate 28, Fig. 14 as *C. australis.* This specimen was not one of the original type series collected by Boll at San Antonio but rather a specimen from Arizona selected by Holland to illustrate *C. nemesis.* This specimen is not *C. nemesis* or *C. australis* but a new species *C. arizonensis,* as was proved by genitalia examina-

tion, and I have labeled it as such. I have designated one of the undoubted males of this type series as a lectotype of *Calephelis australis* and have labeled it as such and have also designated one of the females of this type series as a syntype of *Calephelis australis* and have labeled it as such.

Barnes and McDunnough in Contributions to Natural History of Lepidoptera of North America, Vol. 3, No. 1, p. 103 in 1916 considered *C. nemesis* Edwards and *C. australis* Edwards to be the same species. After examination of many specimens of *C. nemesis and C. australis* and their genitalia I would agree that both belong to the same complex species but that *australis* is better considered a subspecies of *nemesis* because of its constancy in general markings (some of which differ from the original description of *nemesis*) and because of some rather slight but constant variations in the genitalia. The overall pattern of genitalia of both male and female of *nemesis* and *australis* is practically the same.

A comparison between *nemesis* and *australis* would indicate that usually the upper wing surface of *australis* is more uniform light reddish brown than in *nemesis,* where it is more chocolate brown. In *australis* there is sometimes an irregular but subdued rather narrow dark shade across middle of both wings (hardly discernible in some specimens) while in *nemesis* this irregular median dark shade or band is always present and wider and much more prominent than in *australis* and the limbal and apical area are often of a contrasting lighter shade than in *australis*. The small black dots between the marginal and sub-marginal lines of metallic markings are always present and usually well defined in *australis* while these spots are sometimes missing (as in the type specimen of *nemesis*) or ill-defined and only faintly discernible as in some other specimens of *nemesis* from Arizona, but in other specimens of *nemesis,* probably the majority, these black spots are present, but not so well defined as in *australis.* The fringes are faintly checkered with white, particularly in wing primaries of both *nemesis* and *australis.*

The general range of *C. nemesis australis* is Texas and bordering Mexico and possibly adjoining states. There is a record of its capture near Mobile, Alabama, (a pair in collection of W. P. Comstock at the American Museum, dated Sept. 10, 1970), but inquiry of Dr. Ralph L. Chermock, University of Alabama, says (in lett.) that he has no other records for the State and that these specimens may have been temporarily introduced with nursery stock or may have been mis-labeled. Mr. Bryant Mather of Jack-

son, Mississippi has no record of its occurence in that State.

A somewhat similar form of *C. nemesis* found at Blythe, California, I am naming in this Revision as *Calephelis nemesis dammersi*. Although *C. nemesis australis* is prevalent in the Texas area, there is a restricted area near Pharr, Texas, where specimens appear to be nearer to nominate *nemesis* than to *australis,* especially in pattern of male genitalia. The life history of *C. nemesis australis* has not been recorded but its food plant is *Clematis drummondi* by my observation and there may be other food plants.

Barnes and McDunnough in Contributions to Natural History of Lepidoptera, Vol. 3 published in Nov. 1916, state that Herman Strecker described *Charis guadeloupe* about 1877 or 1878 from specimens received from Jacob Boll who collected them at San Antonio, Texas. This is the same locality and the same collector from which Edwards had received previously his type series of *C. australis*. Barnes and McDunnough considered Strecker's *Charis guadeloupe* the same as Edward's *Charis australis,* but considered *C. australis* had priority in publication and therefore *C. guadeloupe* was a synonym of *C. australis.*

I have seen and examined Strecker's typeswhich consist of two males and one female at the Chicago Museum and find after careful examination including genitalia that they are the same as Edward's *C. australis.*

In compiling my records and information on *Calephelis nemesis* and its subspecies *australis,* I am greatly indebted to F. Martin Brown of Colorado Springs, Colorado, who has made a very complete study of Edward's life, works and correspondence and has supplied me with much valuable information regarding them.

No. 5B **Calephelis nemesis dammersi,** McAlpine, new sub-species

In June of 1939 I corresponded with the late C. M. Dammers and received some specimens from him of a little metal mark found at Blythe, Riverside Co., California, which appeared to be different than typical *Calephelis nemesis californica* McAlpine. I received a total of twenty-one such specimens from Mr. Dammers, all taken during the end of July (27th to 30th) in 1929, 1930, 1931 and 1935.

At that time he also sent me a single female specimen from the same locality dated Oct. 7, 1929, which was about the same size as the other specimens, but appeared more like *C. nemesis californica,* in coloration, and in having a small and rather indistinct median dark band across the wings. An examination of the

genitalia of this latter specimen shows that it is closer to *C. nemesis californica.* I received no other specimens from Blythe except the above mentioned ones, so in the latter part of July 1964 I went to Blythe and collected in the area where Mr. Dammers had taken his specimens but found no Calephelis.

In my last correspondence with Commander Dammers in March 1943, he states, "Blythe is a city on the banks of the Colorado River at the eastern end of Riverside Co., Cal., although it is in a desert area the banks of the Colorado River have marshy flats at its sides and the food plant of (*C. nemesis californica*) which is Baccharis glutinosa, grows there in quantity. It is a plant that is found in damp places and some desert washes and is widely distributed over Southern California. At Blythe I have taken both forms in exactly the same spot at different times of the year and never found them flying together and *C. nemesis dammersi,* only in mid-summer. *C. nemesis californica,* I know, has several broods a year. "I believe I am the only one who has made captures of *C. nemesis dammersi,* new sub-species and only at the one spot and always in mid-summer and could not find it at other times of the year." He also states in this letter, "I had hoped to work out the life history of *C. nemesis dammersi,* and definitely find out if it is different than *C. nemesis californica.*"

The Blythe specimens look quite different from *californica* being of a lighter basic color and quite like *C. nemesis australis.* The genitalia of both male and female seem to have some slight constant diffferences from *C. nemesis californica,* it has a desert habitat and appears to be on the average a somewhat smaller insect. Typical *C. nemesis californica,* flies in July in other localities but not in Blythe. Because of all these facts I believe that this apparently isolated Blythe population is worthy of subspecies status.

Male holotype, primary wing expanse 22 mm., forewing 12 mm. Upper wing surface of a uniform light brown or tawny color being a lighter more reddish shade of brown than in typical *C. nemesis californica,* which is more of a chocolate brown color. The usual blackish markings, show up better than in typical *C. nemesis californica.* On the basal half of both wings these blackish linear markings form four or five irregular transverse lines across the wings which are more or less concentric with base, the outer of these lines being slightly heavier and exserted at the middle of both wings.

There is no well defined median dark band or shade across the wings as in *C. nemesis californica,* although there is a trace of

some, evidenced by a small slightly shaded irregular spot along inner edge of outer basal transverse line just above middle of forewing. Some specimens of the male paratypes are of a somewhat darker brown shade than in the holotype, and most of the female paratypes are also of a slightly lighter shade of brown than the allotype. There is the usual marginal and sub-marginal row of metallic markings, silvery in color, but only faintly discernible, between which is the usual row of small black dots. The outer metallic line is straight and finer than the inner metallic line which is heavier and broken at the veins. The fringes are light brown faintly checkered with whitish. Top of head light brown, eyes darker brown, antenna dark brown ringed with white at joints, club black, thorax and abdomen are concolorous with upper wing surface.

Lower surface: the legs, thorax, abdomen and lower wing surface are of a light uniform ochre or yellowish color, considerably lighter than the upper wing surface. All markings of the upper wing surface are repeated and are more definitely defined due to the light ground surface, and the metallic markings are silvery and prominent.

The outer basal irregular transverse line of small linear markings is single and not apparently doubled or shaded inwardly as in *C. nemesis californica.*

Female allotype, primary wing expanse 22mm., forewing 12 mm. Very similar to male holotype in color and markings on both upper and lower surfaces. The shape of the primaries are more rounded or square cut and tip not so pointed as in male.

Nothing is known of its life history but evidently Commander Dammers thought that its food plant might be Baccaris glutinosa which is the food plant of *C. nemesis californica.*

A comparison of the genitalia of several specimens of *C. nemesis californica* and of *C. nemesis dammersi,* indicates that in the male the transtilla is inclined to be angled at the middle and blunted at the end in *californica,* while the sides are straighter and the end pointed in *dammersi,* as in *australis.* In the female genitalia the posterior margin of the anterior genitalia plate is flatter and slightly depressed at the middle in *dammersi,* while in *californica* this margin is decidedly angled and rounded off at center. It would appear that in genitalia and in general appearance that *C. nemesis cailifornica,* resembles most typical *C. nemesis,* while *C. nemesis dammersi,* resembles most *C. nemesis australis.*

The holotype and allotype will be deposited in the Los Angeles

County Museum, and paratypes in U.S.N.M. and elsewhere, with permission of the owners.

No. 5C **Calephelis nemesis californica** McAlpnie, new sub-species

Because of the well marked constancy of California specimens of the complex species *Calephelis nemesis* Edw., it would appear that the California *nemesis* population, with exception of some found in the Blythe area, could well be considered also as a subspecies, and especially because of constant additional markings that are not referred to in the original description of *C. nemesis*, and which do not occur in my designated neotype of *C. nemesis* from Arizona.

Male holotype: Primary wing expanse 24 mm., forewing 13 mm. Upper wing surface basic color pale chocolate brown. Both primaries and secondaries being crossed in the middle by a prominent irregular darker brown shade or band. On the basal half of both wings there is a series of dark brown or blackish linear markings which form four of five irregular transverse lines across the wings which are more or less concentric with base, the most outward of these transverse lines is the heaviest and forms the outer margin of the median dark band or shade previously referred to. These basal blackish markings cause the basal half of the wings to have a darker shade than the balance of the wing surface. Outwardly beyond the median dark band are two fine silvery or coppery colored metallic lines of markings which are barely discernible, between which is a row of fairly prominent black dots. The outer metallic line is fine and quite straight being parallel to outer edge of wing, while the inner metallic line is heavier, broken at the veins, and outwardly exserted near middle of the primaries. There appears to be a small darker shade at tip of primaries intensified by the black dots referred to previously. The outer edge of primaries is undulated. Fringes are light brown very faintly checkered with whitish, which is more descernible on lower wing surface. Top of head, thorax and abdomen are dark brown, eyes lighter, antenna dark brown ringed with white at the joints, with club black.

Lower wing surface, legs, head, thorax and abdomen are of a fairly uniform light tawny color. All markings of the upper wing surface are repeated, only much more prominent due to the lighter ground color. In some specimens there is descernible three very fine metallic markings along the costa of primaries, preceding the inner metallic line. There is usually a slight variable darker narrow shading, being broader at apical area of primaries,

along inner edge of outer basal transverse line, which gives the appearance of this line as being doubled in some cases.

Female allotype: Primary wing expanse 25 mm., forewing 13 mm. Very similar to male in markings, color and shading on both upper and lower wing surface. It is larger somewhat than the male and shape of primary wings are more rounded or square cut and tip is not so pointed as in male. There is evidently a form of this sub-species which is of a light uniform reddish brown color on the upper wing surface, but with no median irregular dark brown shade or band across the wings, but with the metallic markings well defined. The lower wing surface of this form is a little lighter pale yellow color than in typical sub-species *californica* and the black markings are not so heavy and the outer basal line of black markings is single and not divided or shaded on the inner edge. Mr. Dammers sent me two female specimens of this form collected by him, one from Gypsum Canyon, Orange Co., Cal., dated July 27, 1927, and the other from Riverside dated June 1, 1930.

I have seen a series of fifty-five specimens, forty-five males and ten females from counties in California lying in or south of Los Angeles County, California. The dates of capture of these specimens range from late June to the early part of October. The genitalia seem to be quite constant in both male and female, following the general pattern of *C. nemesis* but with some constant variations, not mentioned in the original description of *nemesis,* such as the dark spots between the two metallic lines which are prominent in *californica.*

A partial life history of *C. nemesis californica* sub-species is recorded in Vol. 31, Part I, 1932, Bulletin of the Southern California Academy of Sciences by Dr. John A. Comstock and C. M. Dammers. Its food plant is *Baccharis glutinosa* Pers. and it is at least double brooded.

I am particularly indebted to some private collectors in California, in addition to the Los Angeles County Museum for use of material and information namely the late C. M. Dammers, Dr. John Comstock, F. C. Thorne, Lloyd Martin and Christopher Henne.

The holotype and allotype will be deposited in the Los Angeles County Museum, and paratypes in U.S.N.M. and elsewhere, with permission of the owners.

No. 5D **Calephelis nemesis bajaensis** McAlpine, new sub-species

In November 1966, I received fifty-five Calephelis specimens from Carnegie Museum that had been collected in October, November and December 1961 near the southern end of Baja in Mexico by the Cary-Carnegie expedition. Most of the localities are labeled Ro. Palmarito, A. San Bernardo, Sierra Laguna and San Jose del Cabo. All of the specimens, except one (which proved to be *Calephelis wrighti*) were evidently *Calephelis nemesis,* being very similar in size, coloration and markings on both upper and lower wing surfaces to *nemesis californica.* I examined the genitalia of thirty of these specimens, nineteen males and eleven females. In examination of the male genitalia I was particularly struck by the slimness and extreme length of the valvae, as well as the heavy armature at its posterior end, thus differing from the usual *Calephelis nemesis* from other localities. The balance of the male genitalia, transtilla with processes, etc. were similar to those in *C. nemesis* from other localities. The general pattern of the female genitalia is quite similar to that of *C. nemesis californica* and *C. nemesis* from some other localities.

As accurate specific and sub-specific determination in the genus Calephelis is largely based upon constant structural difference in genitalia, rather than superficial characters of the butterfly which are very similar in all the species. It would appear that this small somewhat isolated population of *C. nemesis* with its constant structural variation in male genitalia, as stated above, should be considered a sub-species.

The holotype and allotype will be deposited in the Carnegie Museum and some of the paratypes will be deposited in U.S.N.M. and other museums with permission of Carnegie Museum.

No.6 **Calephelis laverna** Godman and Salvin 1880

Charis laverna Tran. Ent. Soc. 1880, p. 125.
Charis caenius, synonym Godman and Salvin.

Male type, wing expanse 25 mm., forewing 11 mm. Coloration of the upper surface is a rather bright light reddish brown, with the usual black basal markings fairly well defined forming four or five black broken lines concentric with the base, the outer line being slightly heavier and inclined to be shaded inwardly to form sometimes an indistinct narrow black shade or band midway across both wings.

The two marginal metallic lines are silvery and rather prominent and the black dots between them are fairly large and well defined. The inner line of these metallic markings is heavier,

irregular and more noticeably broken at the veins than the outer metallic line. The inner metallic line is also decidedly exserted outwardly between median veins 1 and 2 as in *C. virginiensis* and several other Calephelis species. The light reddish brown basic color of upper wing surface is particularly noticeable between the two metallic lines. The black dots between the two marginal silvery lines are located nearer the outer silvery line. The fringes are pale brown with occasionally one white checker spot near apex of primaries in both sexes, which is only noticeable in fresh specimens. The antenna are black, ringed with white at the joints. It would appear that the summer broods are somewhat brighter in color than the winter broods.

The color of the lower surface is a light reddish brown, with all markings of the upper surface repeated and well defined, the two silvery lines being particularly prominent.

The female which is found in company with specimens similar to the above described male, has upper and lower surfaces similar in coloration and markings to the male. The shape of the wings of the female are more square cut and rounded than in the male, the primaries of the male being slightly narrower with tip somewhat pointed.

The genitalia of both male and female are well defined and fairly constant in specimens from near the type locality V. de Chiriqui. It is also recorded from Venezuela, Colombia, Ecuador and adjoining Brazil. However, there seems to be a constant noticeable difference in the female genitalia and to some extent in the male, in specimens of *laverna* from Trinidad and adjoining Venezuela so I have proposed that these be designated as a new sub species *trinidadensis.*

The male type of *Calephelis laverna* is in the British Museum and they have a large number of specimens of this species obtained from various collectors over the many years. I have examined and made genitalia slides or preparations of more than 80 specimens of laverna and its sub species *trinidadensis,* received principally from the British, American and Carnegie Museums. Paratypes will be deposited in U.S.N.M., A.M. and C.M. with permission of the owners.

No. 6A **Calephelis laverna trinidadensis** McAlpine, new sub-species

Male holotype, primary wing expanse 23 mm. forewing 12 mm. Coloration and markings of upper and lower surface and shape

of wings and fringes are very similar to *C. laverna.* The shape of wings and fringes are also similar to type of *C. laverna.*

In the male genitalia compared with nominate *laverna,* the valvae are a little more robust with usually not so much armature at the posterior end, the transtilla is much shorter and not so slender and pointed, and not as curved laterally at posterior end.

Female allotype, primary wing expanse 23 mm., forewing 12 mm. Coloration and markings of upper and lower surface similar to male holotype. The females are usually slightly larger than the males, and the shape of the primary wings is more rounded and square cut.

In the female genitalia the complete genital plate is flatter and the posterior part of the plate is also flattened and not so elongated as in female of typical laverna. The genitalia characters are quite constant in this sub species.

The range of this sub species of *C. laverna* is Trinidad and adjoining Venezuela. I have examined and made genitalia preparations of 24 specimens of this sub species. The type locality is St. Ann, Trinidad, British West Indies, while the allotype is from Botanical Gardens, Port of Spain, Trinidad. The holotype and allotype are to be deposited in the American Museum and some paratypes are to be deposited in U.S.N.M., B.M. and C.M. and some others with permission of the owners.

No. 7 **Calephelis fulmen,** Stichel 1910

Berliner "Entomologische Zeitschrift," Vol. 55, page 103.

An English translation of his description is as follows:

"Habitus as *C. iris* (Stgr.) Apex of forewing somewhat produced. Wing above deep brown, distally somewhat lighter reddish brown, in basal area of both wings indistinct black crosslines, beyond the middle a blackish band. Near the distal margin a row of black spots, which are enclosed on both sides by a silver line. The one nearest body of these lines in the forewing strongly zigzag, in the hind wing strongly bowed and wavy, the outer one parallel to the wing border. Underside light red brown. Both wings in the basal half, with 4 fine black lines more or less arched, partially puntcate, in general however, more continuous than in related species. In the outer part are two silver lines which are proximally less zigzag than above, stronger than those running parallel with the border, black spots between the two, in the fore-wings indistinct. Fringes brown, interrupted by white in places in the fore-wing. Length of forewing 14 mm. Type 1 ♂ No. 3485 Costa Rica, (San Carlos) 1 c.m."

The Zoological Museum of Berlin in 1963, through the late Prof. Eric M. Hering and his successor, Dr. H. J. Hannemann, was most cooperative in sending me the type of *Calephelis ful-*

men, together with another male specimen of fulmen, with Stichel's label and identified by him as *C. fulmen* according to Dr. Hering. They permitted me to make genitalia slides of these specimens. Photographs of the type were also sent.

I have carefully examined the type of *Calephelis fulmen.* There are four labels on it as follows: printed label, white with black border, Costa Rica, San Carlos, C. C. H. Stichel., printed label, red with black border, Typus., printed label white, 3485., very large pale green label with black border (hand written by Stichel) *fulmen* Stichel.

The othe specimen of *C. fulmen* has three printed labels: (1) white label with black border, Chirique Ribbe, (2) white label, 2493, (3) white label with black border, C. C. H. Stichel. The two specimens look quite alike superficially the latter specimen being slightly smaller in wing expanse. The above description of *Calephelis fulmen* by Stichel is quite good and his type and the other Stichel specimen is about average size in wing expanse about 24 mm., forewing 13 mm.

The apex of the forewing in his type is not produced as much (not so falcate) as in some other specimens. This falcate wing apex seems to be a main superficial distinguishing characteristic of the *C. fulmen* group. Another very noticeable feature of the upper surface of *fulmen* is the very prominent irregular dark median band across both wings and the three large black spots with dark shading located between the two silvery lines at the apex of the primaries. The fringes are concolorous with upper surface and lightly checkered with white, more distinctly near apex and outer angle of primaries. The lower surface of type *C. fulmen* is of a uniform pale reddish brown color with markings of upper surface repeated and well defined. The outer basal line or median line of small broken black markings is single and not shaded.

In examination of the genitalia of the type and the other specimen referred to, it was noted that tip of the abdomen of the type, had been broken off or removed before I received it and what was left was of little use. However, a good genitalia slide was made of the specimen from Chiriqui, known also as Volcan Chiriqui, Panama, which is not far from type locality San Carlos, Costa Rica.

The specimen from Chiriqui is quite similar to the type in general markings and size, although the silver markings on the upper wing surface are faint as compared with the type. The genitalia of the type are lost or destroyed, and this specimen

was identified by Stichel as *C. fulmen* according to Dr. Hering. In view of these facts I have selected the Chiriqui specimen as a neotype of *Calephelis fulmen*. The original description of the type by Stichel, with the additions I have called attention to, would apply well to this neotype.

The genitalia of this neotype of *Calephelis fulmen* is distinctly different from all the other species of Calephelis, in having the anterior lateral finger-like process, one of two that occur on each side of the transtilla of the valvae, very long, and extending well over and beyond the other two posterior processes. *Calephelis fulmen* typifies this distinctive constant character of a very long anterior finger-like process on the transtilla and I propose calling this group the fulmen group, two other species mexicana and sixola also belong to this group. The butterflies of this group all look superficially like the usual Calephelis species, and the wing venation is the same and the other genitalia characters are also quite similar with the above named exception. There is slight variation in the length of the finger-like processes on the transtilla in some other Calephelis species, but nothing approaches the extreme length of the anterior processes as occur in the fulmen group.

There appears to be considerable variation in genitalia of both male and female of *C. fulmen* in different localities, but present knowledge is insufficient to warrant sub specific recognition. However because of this variation in a considerable series of specimens from Tabasco, in the Yucatan Peninsula and British Honduras a sub species may be warranted from this area. Life history work in the fulmen group is desirable and would help determine this. My figures of the genitalia of both male and female of *C. fulmen* show some of these variations but the general pattern of the genitalia is quite similar in all of them.

Females of *Calephelis fulmen* are very similar to the males in general markings, but are a little larger in wing expanse, the average being about 26 mm. forewing 13 mm. In the female the primary wings are more rounded and square cut than in the male, and the wing tip is produced or falcate as in the male.

Females of this species have been determined by superficial characters that are similar to the male, and by congruence of localities. The female genitalia of *C. fulmen* are not so well defined as in the male. There are some comparatively small variations in different populations, but the over all pattern is much the same.

I have examined and made genitalia slides or preparations of seventy specimens of *C. fulmen* of which fifty were male and twenty female. There is considerable variation in extreme sizes of both male and female. The basic coloration of upper surface varies in light or dark brown shades, but the markings as outlined are quite constant.

The known distribution of *C. fulmen* is through Central America, as far south as Panama and north through Nicaragua, Honduras, Guatemala, British Honduras, and in Mexico, through the Yucatan Peninsula on the south, and north through the states of Chiapas, Oaxaca, Guerrero, Veracruz and San Luis Potosi.

The original type and proposed neotype will be deposited in The Berlin Museum and paratypes in U.S.N.M., C.M., A.M. and Mex. Nat. Mus., B.M. and some private collections, with consent of the owners.

No. 8 **Calephelis mexicana** McAlpine, new species

Calephelis mexicana belongs to the fulmen group and looks very similar to *C. fulmen,* the main means of certain identification being in the genitalia.

The male genitalia of *C. mexicana* differ from those of *C. fulmen* in the length of transtilla, which does not extend over the end of the valvae, and is usually slightly notched at its end, and also in the general shape or pattern of the valvae as shown in my figure.

Male holotype primary wing expanse 25 mm., forewing 15 mm. (which is about maximum wing expanse of material I have examined). I have examined and made genitalia slides or preparations of twenty-five male specimens and find there is considerable variation in size. The smallest of the male specimens is 21 m.m. in wing expanse. Most of the material is not in very good condition. The holotype however, is a nearly perfect specimen. It is in collection of C. C. Hoffmann, No. 2251 in the American Museum and was collected at Mirador, Veracruz, Mexico, May 25, 1908. The outer edge of the forewing is squared off at the middle and its apex is rather prominently produced or falcate, which is a distinguishing character of the *fulmen* group.

The basic color of the entire upper wing surface is of a rather light chocolate brown, which varies in intensity in specimens. There is a prominent dark brown irregular median band or shade across the middle of both primaries and secondaries, its outer edge being the heavier black outer line of four irregular lines of

small linear black markings, concentric with the base of wing and which are only barely discernible on the upper wing surface. Beyond this median band are two very fine marginal silvery lines not very discernible, between which is a row of rather prominent blackish dots or dashes, the three black dots or dashes near the apex of the primaries being more prominent than the others. The inner metallic line is irregular scalloped and broken at the veins, exserted at middle of the wings, and is a little heavier than the outer silvery line, which is close to and parellels the outer edge of the wings. The fringes are very light brown checkered faintly with white. The antenna are black, faintly white at joints, eyes thorax and abdomen are dark brown.

The holotype of *C. mexicana* is a little larger than the type of *C. fulmen* and differs mainly from *C. fulmen* on upper wing surface in that the silvery markings are not nearly as prominent as in *fulmen,* causing it to have more of a uniform brown appearance, although the dark brown dots or dashes between the silvery lines are larger and more prominent in *C. mexicana.* The prominence of the silvery marking on the type of *fulmen* is exceptional and does not occur in the other *fulmen* specimens at hand, which look very similar to *C. mexicana.*

The entire lower wing surface of the holotype of *C. mexicana* is of a light uniform reddish brown color and markings of the upper wing surface are repeated, but are more discernible. The outer basal line of broken dark markings is well defined, single, and not shaded inwardly.

Female allotype primary wing expanse 25 mm. forewing 15 mm. (about maximum wing expanse of material at hand, which consists of six specimens, the smallest wing expanse being 21 mm.). The color of the upper wing surface of the allotype is a slightly lighter brown shade of brown than on the holotype, but the median dark band and other markings are similar. The primaries are more rounded than in the male and the apex of primaries is produced or falcate as in the male.

The lower wing surface of the allotype is of a paler, more yellowish color than in the holotype, but the median dark band and other markings are similar.

The female genitalia of *C. mexicana* are distinctive and quite different from those of *C. fulmen* as shown in the figures. Nothing is known of the life history of *C. mexicana.* Its distribution from specimens at hand is as follows: States of Oaxaca, Veracruz, Morelos, Hidalgo, San Luis Potosi, Nayarit Tepic and Sinaloa, in Mexico.

C. mexicana is sometimes found in the same locality as *C. fulmen* in Mexico, especially in the Veracruz area.

The holotype will be deposited in the American Museum and allotype in the U.S. National Museum with paratypes being distributed to Carnegie Museum Zoological Museum of Berlin, Mex. Nat. Mus. and some other Museums with permission of the owners.

No. 9 **Calephelis sixola,** McAlpine, new species

This species belongs to the *fulmen* group.

The male holotype was collected at Sixola River, which is located in the southern end of Costa Rica, in Sept. (no date) and was in the Schaus and Barnes collection in the U.S. National Museum. I know of only one other male specimen labeled Costa Rica, Joicey bequest in the British Museum.

Male holotype, primary wing expanse 24 mm. forewing 13 mm., the same size as the original *C. fulmen* type. The holotype is only slightly smaller than the only other male specimen. The upper surface of the holotype is almost identical with that of the original type of *C. fulmen* being of a light uniform chocolate brown, with a rather prominent dark irregular blackish band across the middle of both primaries and secondaries, its outer edge being the heavier black outer line of about four irregular lines of small linear black markings which are concentric with the base of wings, but are only barely discernible on the upper wing surface. Beyond this median dark band are the two rather fine sub-marginal and marginal silvery lines between which is a row of small black dots or dashes, the three anterior dots larger and more prominent than the others. The submarginal silvery line is irregular, broken at the veins, outwardly exserted at the middle of the primaries, and a little heavier than the other marginal silvery line which parallels the edge of the wing. The outer edge of the primaries is undulated being squared off at the middle, and the tip of wing is slightly produced or falcate. The fringes are light brown faintly checked with white.

The lower surface is rather light reddish brown similar to that of the original *fulmen* type, with lines and markings of the upper surface repeated, but better defined. The outer basal line of broken dark markings is well defined, single, and not shaded inwardly.

The male genitalia of *C. sixola* differs mainly from those of the neotype of *fulmen* in the much shorter length of the transtilla

which extends only just beyond the end of the valvae, and the slightly shorter length of the finger-like processes, with the anterior process not exceeding beyond the end of the valvae, which it does considerably in the neotype of *fulmen*. The shape of the valvae as shown in the figures is somewhat different than in neotype *fulmen*.

Female Allotype, primary wing expanse 28 mm., forewing 14 mm. The allotype is an exceptionally large specimen. There is only one other female specimen in the type series and it has a primary wing expanse of 23 mm. The upper and lower surfaces of the allotype are very similar in color and general markings to the holotype, only somewhat heavier. The primaries are more rounded and tip of wing a little more produced or falcate than in the male holotype. The other female in the series has lighter shades of brown on both wing surfaces but with similar markings. The female specimens are assumed to be the female of *sixola*. The allotype and other female in the series are from Banana River and Juan Vinas respectively, and the holotype is from Sixola River, all localities fairly close together in Costa Rica.

The allotype is labeled Banana River, Costa Rica, Mar. 1907 in collection of Wm. Schaus in U.S. National Museum. The genitalia of the allotype is figured and it appears to agree fairly well with the genitalia of the only other female in the type series but is quite different from type *fulmen*.

It is possible that *C. sixola* may be considered only a sub species or varient of *C. fulmen* but by obtaining more material and doing life history work in the future, its status will be more fully determined.

The holotype and allotype will be deposited in the United States National Museum and paratypes will be deposited in Carnegie and British Museums where the specimens were obtained.

No. 10 **Calephelis costaricicola,** Strand

Calephelis costaricicola was described by Strand in Lepidoptera Niepeltiana in 1916 on pages 19 and 20 and figures on plate 14, figures 20 and 21.

The following is a translation on his description which was published in German.

"A male from Costa Rica is probably near *C. fulmen*, but the forewings are not lighter colored nor more reddish distally; the dark markings on the upper side are not black but dark brown to blackish brown; there is no distinct row of "sublimable" dark dots, while instead of sharply defined dots only indistinctly bordered, more or less confluent scrawls are present; these

are bordered not by two silver, but by lead-colored, weakly shining, narrow, indistinct and irregular lines; the underside is dull reddish-yellow, without any coherent lines whatever, only the outer of the two metallic lines, which may be called silver white here, seems nearly coherent because it is finely interrupted only at the veins. The row of black dots passing nearest the silver line is the plainest and most regular, whereas the dots of the basal half do not form a regular row. The dots between the silver lines are small to the point of vanishing in both wings. The fringe of both wings dark black and dappled gray above and below, no where white. Length of forewing 11 mm. The dark median-band on the upper side of both wings is very distinct and as conspicuous as the sharp and "drawn-out" apices of the forewings, characters which refer the species to the neighborhood of *C. fulmen*. —I have seen a very similar form, determined as *C. australis Edws*.; this, however, differs by having white and here and there black fringe: among other things."

The male specimen of *Calephelis costaricicola* as described by Strand appears to be an extreme varient or a badly worn specimen as the usual markings on both upper and lower wing surfaces are not very discernible.

Every effort was made to locate the type of *C. costaricicola* through European Museums, but to no avail and the type appears to be lost. I have selected a specimen of Calephelis from Monte Rodondo Costa Rica, collected by Cary on March 2, 1902, which is in the Holland collection at Carnegie Museum, as a neotype, as it is the same size as the type and appears quite like the original illustrations and description of *C. costaricicola*. I have also selected a female Calephelis from the same locality in Costa Rica which was also collected by Cary on the same date as the proposed neotype, and which is also in the Holland collection at Carnegie Museum, as the probable female of the species, and have labelled it as such.

Male *C. costaricicola*, neotype, McAlpine, primary wing expanse 22 mm., forewing 11 mm. Coloration upper wing surface, a rather uniform chocolate brown color with the usual black and metallic markings which are not very discernible. The two marginal metallic lines are leaden colored and barely discernible and the black dots between them are also very faint. The mid-dorsal dark band across both wings is narrow, irregular, and also not very prominent. The fringes are brown, with whitish dappling, barely noticeable. The lower wing surface is of a uniform dull reddish yellow with all markings of the upper surface repeated only more distinct. The two marginal metallic lines are silvery. The outer mid-dorsal basal line of black markings is inclined to be doubled or shaded inwardly. The apices of the forewing are somewhat drawn out.

Female *C. costaricicola*, of neotype, McAlpine, primary wing expanse 20 mm., forewing 10 mm. Coloration and markings of

upper wing surface similar to male neotype only that the mid-dorsal dark band is a little more prominent. The coloration and markings of lower wing surface is also quite similar to male neotype only the markings are a little heavier and more prominent and it is assumed to be the female of the species as it was found in the same locality at the same time by the same collector, Cary.

C. costaricicola is practically indistinguishable from *C. argyrodines* superficially, but the genitalia are constantly somewhat different as indicated in the drawings, enough I believe to warrant specific designation. The male genitalia of both *argyrodines* and *costaricicola* look somewhat similar but the female genitalia are more distinctive. I have examined and made genitalia slides of a series of fourteen males and three females of *C. costaricicola* near neotype, from Costa Rica, that are in collections of Carnegie Museum, British Museum, American Museum and U. S. National Museum. I have seen only one specimen, a male Calephelis from Costa Rica that appeared to be nearest to the type of *C. argyrodines.*

I have been somewhat puzzled by a large series of Calephelis collected by E. C. Welling of Merida, Yucatan Mexico, from Quisache and Baleu, Guatemala, consisting of about seventy males and fifty females which appear to be nearest *C. costaricicola* neotype and thirty males and nine females that appear to be nearest *C. argyrodines,* by genitalia examination. In this series the male genitalia seem to vary somewhat and I wondered if there could be hybridization between these species in this area, as the type locality of *C. argyrodines is* Duenas, Guatemala, which is close to Quisache and not far from Baleu. I have made drawings of some of these genitalia variations. Life history work on these species in this area would be very desirable in determining the relationship of these species. It is to be noted that in both species that the fringes of wings are inclined to be somewhat checkered with whitish. The range of *C. costaricicola* neotype is through Costa Rica to and through Guatemala while the center of distribution of *C. argyrodines* appears to be Guatemala, from material at hand.

The neotype of *C. costaricicola* and assumed female, together with genitalia slides of same, will be deposited in the Carnegie Museum and paratypes of same will be deposited in U. S. National Museum, American Museum, British Museum and some others with consent of the owners.

No. 11 **Calephelis perditalis** "Barnes and McDunnough" 1918

Contributions to the Natural History of the Lepidoptera of North America, Vol. 4, No. 2., 75, 76, Plate 12, Figures 5, 6, 7.

Calephelis perditalis is a complex species with primary wing expanse of male paratypes about 21 mm. with forewing 11 mm. and of female paratypes about 22 mm. with forewing 12 mm. The type series consists of six male and six female specimens taken at San Benito, Texas, are deposited in the United States National Museum.

Ground color of upper surface is a uniform rather dull dark reddish brown. All markings on upper wing surface including the usual two silvery marginal and sub marginal lines are not very distinct. On the upper surface are the usual four or five basal concentric lines of irregular black markings, the outer line of which is geminate or doubled in the type species but not always in some other specimens of persumed perditalis. This outer line forms the outer margin of an irregular dark median band or shade across both wings which is sometimes present. This outer basal line of markings is much closer to the inner silvery line than in *C. nemesis*.

The lower surface is of a lighter tawny color and all markings of upper surface are repeated and quite prominent. The inner silvery line of the primaries is heavier and exserted at the middle as in *C. virginiensis* and *C. muticum,* while the outer silver line is straight and finer. The row of black dots between the silvery lines is prominent. The primaries of both male and female are rounded and quite similar, making sexes sometimes difficult to separate. The primaries are not quite so rounded as in *C. virginiensis*. In *C. nemesis* and some other species the primary wing shape of the males is narrower and apex more sharply pointed than in *C. perditalis*. The fringes are light brown and in the primaries are checkered with white at apex, center and inner angle but this checkering is often not very distinct.

Some specimens of *perditalis* are darker and smaller than specimens of the type series and may be seasonal forms and one can only be sure of identity by careful genitalia examination.

There appears to be some considerable rather slight variation in the genitalia of both male and female and especially in the female, so am illustrating some of these varients. In this group I am also showing the genitalia of what appears to be a ♀ aberration of *C. perditalis,* which was collected by Roy O. Kendall in

Cameron Co., Texas, on October 10, 1964. This specimen is a distinct aberration, which is apparently a rare occurance in genus Calephelis. I have seen and examined several thousand specimens of Calephelis but never before seen anything like this one or one that could even be considered slightly abberant, which speaks well for the constancy of this genus. A description of the abberant is as follows: Upper surface, uniform dull brown color with all markings indistinct, but where visible, corresponding with perditalis. There is no visible dark median band or shade across the wings. The lower surface is where the distinct abberation occurs. The lower part of the wing from inner edge of sub marginal silvery line to thorax is pale uniform yellowish color, not tinged with reddish, with most of the basal irregular black markings missing, except the outer line of black markings, which is fairly well defined and single. From inner edge of sub-marginal silvery line to outer edge of marginal silvery line is a blackish band or shade on the primary wings, which extends through the secondaries where it is spotted centrally, with yellowish, of the same color as on basal part of the wings. There is a trace of silver overlaying this blackest band.

The life history of *C. perditalis* has not been completely recorded but Mr. & Mrs. Roy Kendall of San Antonio have reared it on *Eupatorium odoratum* and it is probably several brooded.

The general range of the species is from southeastern Texas through eastern Mexico to approximately Mexico City. I have seen *perditalis* specimens from San Benito, (type locality), Brownsville, Pharr, Laredo, Corpus Christi, Skidmore and Kerrville in Texas. I would also identify as *perditalis*, specimens from Victoria, El Salto, and Tamazunchale, Mexico. In this Revision I am describing a new sub-species called *Calephelis perditalis donahuei* taken near Jacala, State of Hidalgo, just north of Mexico City, as there appears to be some constant differences in genitalia from types, which would justify this. Jacala is about three hundred and seventy-five miles south of the type locality of *perditalis* in Texas. In this paper I am also describing a new species which is evidently closely related to *C. perditalis*, with type locality at San Jose, Purua, State of Michoacan, Mexico, which I am naming *Calephelis matheri*. Intermediate forms between this species and *C. perditalis* are found in adjoining and nearby areas and only life history work will fully determine the status of this species and *perditalis* and their intermediate forms.

In 1961 I contributed the section on Calephelis in Paul R. and Anne H. Ehrlich's Book, "How to know the Butterflies" and

at that time, called *C. perditalis* a sub-species of *C. nilus* (Felder), based on my examination of the male type specimen with genitalia of *C. nilus* in the British Museum in 1952. In 1952 I noted that the genitalia were somewhat damaged, particularly at the end of the transtilla which seemed split and spread. In 1968 I visited the British Museum and re-examined the type specimen of *nilus* which was in fairly good condition, and also the genitalia which were badly damaged, more so than in 1952 when I first examined them. The genitalia were so badly damaged it was impossible to reconstruct an accurate drawing of same. The type specimen of *nilus* looked quite similar to *perditalis* and in the original description of *nilus* by Felder it was called a female, (later on genitalia examination proved it to be a male). Barnes and McDunnough noted that it was difficult to separate the sexes in *C. perditalis,* so in that respect they were quite similar. I noted that there is no doubling of the outer transverse basal line on the lower wing surface of *nilus* type, as there is on the types of *perditalis,* although that doubling I have observed does not always occur in other specimens of persumed *perditalis* from near type locality.

Taking everything into consideration, particularly the badly damaged genitalia of *C. nilus* and the great distance between recorded type localities of *C. nilus* (Venezuela), and *C. perditalis* (Texas), and my records of fairly typical *C. perditalis* which extend south only to about Mexico City in Mexico, I have come to the conclusion that *C. perditalis* is a distinct species and not a sub species of *C. nilus,* which I consider a doubtful species or species inquirenda.

No. 11A **Calephelis perditalis donahuei** McAlpine, new sub-species

Male holotype, expanse of primary wings 21 mm., forewing 11 mm. There is one other male specimen which was made a paratype, having expanse of primary wings 20 mm. These two specimens were taken by J. P. Donahue, 3 miles S.W. of Jacala, Hidalgo, Mexico, Elev. 5800 feet on August 1, 1963. One other male specimen taken by J. P. Donahue at the same locality and on the same date appears to be somewhat different than the two specimens above referred to, and is like *matheri.*

Upper wing surface of holotype is of a rather dark brown color with all markings not very well defined. On close examination the usual four or five concentric basal irregular and broken

lines of black markings are just descernible on lower half of wing, the outer of these lines being somewhat heavier and marking outer edge of a rather narrow median shaded area across both wings, which is not very discernible. The two silvery lines marginal and sub marginal with black dots between are fine and not very discernible. The fringes are pretty well worn but appear to be light brown.

The lower wing surface is of a uniform light ochre or yellowish color with all markings of the upper surface repeated and well defined. The outer basal line is single and not doubled as in type *perditalis.*

Female allotype primary wing expanse 23 mm., forewing 12 mm. It was the only female specimen taken by J. P. Donahue 3 miles S.W. of Jacala, Hidalgo Co., Mexico, on August 1, 1963. Upper wing surface is similar in color to that of the holotype but the usual markings are a little more well defined, although not very discernible. The median slight shaded area just discernible in the holotype is not discernible in the female. The lower surface is of a uniform light ochre or yellowish color with all markings of the upper surface repeated and well defined. The outer basal line is single and not doubled. The fringes are worn but appear to be light brown.

The male genitalia is quite similar to type *perditalis* but does not have a jog at anterior end of transtilla as in type *perditalis.* The posterior end of genital plate of female is somewhat different from female type *perditalis.* Life history work of this sub species is very desirable.

The holotype and allotype will be deposited in the U.S.N.M. by permission of Michigan State University, for whom J. P. Donahue collected them, and paratype will be deposited in Michigan State University.

No. 12 **Calephelis wrighti,** Holland 1930

Annals of the Carnegie Museum 20: 5, 6.

This butterfly is from 19 to 25 mm. in expanse of primary wings, forewing 12 mm. and is outstanding in beauty and trimness. The color of the upper surface is of a rather uniform reddish brown, being lighter in some specimens, and the whole wing surface seems to be overlaid with a faint delicate whitish film. The usual black markings and the two silvery metallic lines are not very discernible on the upper surface and the black spots between the silvery lines are rather small. The fringes on both

fore and hind wings are conspicuously checkered with white. The outer edge of the male primary wing is quite undulated being squared off at the middle and the tip is pointed, while in the female the border of the forewing is more squared off and rounded. As usual the female is larger than the male. The genitalia characters of both male and female are distinctive from other Calephelis as shown in my figures.

The life history has been partially worked out under the name of *Calephelis australis* by the late Dr. John A. Comstock and the late Commander C. M. Dammers in Bulletin of the Southern California Academy of Sciences, Vol. 27, Sept.-Dec. 1928 and its food plant is *Bebbea juncea.* The larva is covered with long white hairs as in *muticum* and *borealis.* It has normally two broods per year, the fall brood, more common according to Lloyd Martin, and is found in the lower desert of southern California. The type specimen is in the California Academy of Sciences. The range of this species is southern California and southwest Arizona, and that part of Mexico immediately bordering these states, including the peninsula of Baja California, Mexico and Puerto Libertad in Sonora, Mexico.

No. 13 **Calephelis muticum** McAlpine 1937

Bulletin of the Brooklyn Entomological Society, 32:43-49, Pl. 1, Figs. 1 to 7.

It has expanse of primary wings of about 25 mm., forewing 13 mm., being a little smaller than *C. borealis* for which it once had been mistaken. The color of the upper surface is of a rich mahogany color while the lower surface is of a light tawny or fulvous, the color being fairly uniform. This species is quite similar in general appearance and markings to *virginiensis* but is larger and the upper surface is of a dark mahogany brown color although worn specimens become more yellowish as in *virginiensis.* There is usually a slightly suffused very narrow dark band or shade across median area of both wings but not so prominent as in *C. borealis.* The two rows of metallic markings on the upper wing surface are silvery and more prominent than in *borealis.* The inner metallic line is irregular and noticeably exserted at the center of forewing as in *virginiensis.* All markings of the upper surface are repeated on the lower surface, but are more prominent due to the lighter ground color. The fringes are light brown with no white checkering. The genitalia characters of the male are good, and the female genital plate is quite similar to that of *C. virginiensis,* as shown in my figures.

The complete life history of *C. muticum* has been worked out by the author and recorded in Bull. Brooklyn Ent. Soc., 33:

111-121 (June 1938). *Calephelis muticum* usually occurs on springy land along small springs adjacent to streams or in openings in tamarack bogs where its food plant the swamp thistle (*Cirsium muticum*) occurs. It is single brooded, the adults usually emerging the latter part of July. The egg is turban shaped and of a delicate coral pink color when first laid. The larva has eight stages and hibernates during the winter, usually in the fourth stage, at the base of its food plant among the small hairy leaves of its food plant. The larva is fringed with long white hairs and has long white hairs projecting upward mid dorsally, as in borealis. The chrysalis is suspended by a silken girdle and is covered evenly with a cocoon like mass of the cast off long hairs and exuviae of the last larval stage. *C. muticum* is a comparative rare species, as its habitat is quite restricted and the flight period very short, being only about a week or two. The type locality is Willis, Washtenaw Co., Michigan. The recorded occurance of this species is Ohio, near Columbus, Southern Michigan in Lower Peninsula south of about Grand Rapids latitude, Illinois near Chicago, Wisconsin near Milwaukee and Missouri near Willard, also from Pennsylvania near Pittsburgh.

The holotype and allotype are deposited in the U. S. National Museum.

I am including in this Revision a copy of the plate showing the early stages of *C. muticum* as published in Bulletin of the Brooklyn Entomological Society in 1938 in my life history of *Calepheles muticum*, as it is quite typical of the few known life histories of Calephelis.

No. 14 **Calephelis rawsoni** McAlpine 1939

Bull. Brooklyn Ent. Soc. 34:75-80, Plate figs. 1 to 9 (1939).

This butterfly is about 25 mm. in expanse of primary wings, forewing 12 mm. The color of the upper surface is a dull reddish brown. In fresh specimens the outer line of the black basal markings near center of both wings is slightly heavier, forming sometimes the outer edge of a narrow suffused dark band across both wings. The other lines and the two marginal and sub marginal silvery metallic lines are hardly discernible on the upper surface while the black spots between the silvery lines are quite prominent. The lower surface is light uniform tawny, with all the markings of the upper surface repeated and well defined. The inner row of metallic markings are much heavier than the outer row and is wavy and exserted at the middle of the primaries much as in *virginiensis* and *muticum*. The outer edge of forewing is slightly undulated and square cut at the center, and the fore-

wing of the male is narrower than that of the female with its apex somewhat pointed, while the forewing of female is larger and more rounded. Fringes of the wings are light brown and on forewing are slightly checkered with white, at apex, center and inner angle but not noticeable on secondaries. The genitalic characters of both male and female are good as shown in my drawings.

The life history of *C. rawsoni* has not been completely recorded, but Roy O. Kendall of San Antonio has reared it on Epatorium havanense and Eupatorium, griggi. It probably has two or three broods, judging from dates of specimens. Its range is Southern Texas, having been recorded from Bexar, Comal, Kendall, Kerr and Travis Counties and to the west in Brewster Co. in Big Bend National Park and one specimen from Lyford in Willacy Co. Texas, most of the recordings being by Roy O. Kendall. The type locality is Kerrville, Kerr Co., Texas and the types are deposited in the U. S. National Museum.

No. 15 **Calephelis freemani** McAlpine, new species

Male holotype wing expanse 22 mm., forewing 12 mm., paratypes, wing expanse 22 mm. to 25 mm. Upper surface of both primaries and secondaries are a dull, rather uniform light brown inclined to reddish, crossed with an irregular and usually indistinct darker brown shade across middle of both wings (this shade being more discernible in some of the paratypes than in the holotype), its outer margin being the more distinct outer line of four or five irregular lines of very small black dashes which are concentric with base of wings, as is usual in most species of Calephelis.

Beyond this outer basal line are the usual two rather fine metallic lines, between which is a row of rather prominent black dots, the outer marginal metallic line being straighter and finer, while the inner metallic line is heavier, irregular and exserted outwardly near the middle of both primaries and secondaries. These metallic lines are leaden in color and barely discernible on the upper wing surface. The fringes are light brown, interspersed with faint whitish checkering, more noticable on the lower surface. The antenna is brown with white at the joints, the club black. The dorsal surface of thorax, abdomen and head is dark brown.

The lower wing surface is of a uniform ochre or tawny color with all the markings of the upper wing surface repeated, but more prominent, due to the light ground color. There is no doubling of the outer basal line of black markings. The metallic mark-

ings are silvery. The ventral surface of thorax, abdomen, legs and head are concolorous with lower wing surface, and eyes are dark brown. The wing shape is similar to that of *C. rawsoni,* rather elongated and slightly undulated at center of primaries, with somewhat pointed tip in male, more rounded and square cut in the female.

The female allotype is very similar in coloration and markings to the male holotype on both upper and lower surfaces, but with median dark band more prominent.

Calephelis freemani resembles *C. rawsoni* rather closely in shape of wings, coloration and markings. The male genitalia of *freemani* differs mainly from *rawsoni* in the length of the posterior end of the transtilla, which in the former extends only to the end of the valvae or a trifle beyond, while in *rawsoni* the transtilla is much longer and more slender and pointed than in *freemani.* It is to be noted that the length and shape of the transtilla together with valvae are important characters in specific determination of Calephelis. The shape of valvae is more constant in *freemani* than in *rawsoni,* where it is very variable. I have seen a male specimen of so-called *rawsoni* from Chisos Mts., Brewster Co., Texas in Big Bend National Park that seems to be between *rawsoni* and *freemani* in length of transtilla but shape of transtilla is more as in *freemani.*

The female anterior genital plate of both *rawsoni* and *freemani* are quite similar although the posterior margin of the anterior genital plate of *freemani* is somewhat flatter and no so angular as in *rawsoni.*

The food plant and life history of *C. freemani* are unknown. I have a series of eighteen specimens of *C. freemani,* many of which are not in very good condition. Ten of these were collected by H. A. Freeman and three by Stallings and Turner in June 1942 and two were collected by H. A. Freeman in August 1951. These fifteen specimens were collected in the same locality in the Davis Mts., Jeff Davis County, Texas, about twelve miles northwest of Alpine, Texas, along State highway 118, near a small stream. I have since collected in this area several times and so has Mr. Freeman, but no more specimens were found. *Calephelis nemesis* is found also in this area.

The three other specimens, two males and one female, of *C. freemani* were obtained from the American Museum. These specimens are a little larger than the average of the other specimens, being 25 mm. to 27 mm. in expanse. They were collected by O. C.

Poling, June 15, 1928, near Ft. Davis, Davis Mts., Jeff Davis County, Texas.

Because of the rather close similarity of both sexes superficially and in genitalia, *C. freemani* may be considered by some as a sub species of *C. rawsoni* but life history work on *C. freemani* in the future can better determine this.

The holotype and allotype will be deposited in the U. S. National Museum and paratypes elsewhere, with permission of the owners.

In 1961 the author contributed the Calephelis section of "How to know the Butterflies" by Paul R. and Ann H. Ehrlich and made an error in determining this new species as *C. argyrodines*. *C. argyrodines* was described from Guatemala and since 1961 I have had an opportunity to more carefully examine the type and genitalia of *C. argyrodines* and find that my new species *C. freemani* is not *C. argyrodines*.

No. 16 **Calephelis arizonensis** McAlpine, new species

In examining specimens of Calephelis in the U. S. National Museum in 1939 shortly after discovery and publication of *Calephelis rawsoni* from Texas, I noticed a number of specimens of a large species from the Baboquivari Mts. Pima County, Arizona, collected by O. C. Poling, mostly in September and October 1923, but with no data regarding exact location in those mountains. Most of these specimens were not in very good condition and were of a rather uniform light brown color, with the two marginal lines of metallic markings on upper wing surface barely discernible. An examination of the male genitalia of some of these specimens proved they did not belong to the nemesis complex group occuring in that area, but were of an unknown species. Later on in 1939 I received a number of specimens which appeared to be the same species, by genitalia examination, from Dr. A. E. Brower collected by Dr. J. W. Tilden in the later part of March 1938 in Brown Canyon, Baboquivari Mts., Pima Co., Arizona. These specimens were as a rule slightly darker brown than the Poling specimens and were more striking in appearance with a dark irregular, ill-defined median band across both primaries and secondaries and with a small whitish sub-apical area on both wings. In 1949 a few more specimens were received from Dr. Tilden from the same locality. Since then additional specimens of the same species, but resembling more the Brown Canyon specimens were received from other collectors, prin-

cipally Killian Roever, Lloyd M. Martin, Dr. John A. Comstock and Dr. Lee D. Miller, which extended its distribution. There were also a few more specimens in the U. S. National Museum, labeled Baboquivari Mts., Pima Co., Arizona, with no further data. All told, there were eighty-five specimens: Forty-five were of the slightly darker and more distinctly marked form dated February and March which I propose naming *Calephelis arizonensis,* McAlpine, new species, with type locality Brown Canyon, Baboquivari Mts., Pima Co., Arizona. The other slightly lighter form above referred to and collected by O. C. Poling in the Baboquivari Mts., Pima Co., Arizona, but without a more defined location appears to be a seasonal form although it may be a sub species of *arizonensis* but life history work is necessary to fully determine this.

Other localities in addition to the Baboquivari Mts. where a few specimens of *Calephelis arizonensis* have been taken are Sabino Canyon, Santa Catilina Mts., Pima Co., Arizona; Reddington, Pima Co., Ariz.; Madera Canyon, San Rita Mts., Santa Cruz Co., Ariz.; Patagonia Mts., Santa Cruz Co., Ariz.; and Payson, Gila Co., Arizona. All of these specimens were taken in the early part of the year and were near type *Calephelis arizonensis* in appearance.

Male holotype: Primary wing expanse 27 mm., forewing 14 mm. The wing expanse for forty-four other specimens examined ranged from 25 mm. to 27 mm. Upper Surface: Head top medium brown, concolorous with upper wing surface, eyes lighter brown, antenna dark brown with white rings at joints and club black. Dorsal surface of thorax and abdomen dark brown. Basic color of upper surface is rather light brown near to cinnamon brown (Plate 15 Ridgeway colors). On the basal half of both primaries and secondaries there is a series of small blackish linear transverse lines, broken at the veins, more or less concentric with base of wings. The outer of these transverse lines forms the outer margin of a more or less ill-defined but conspicuous irregular dark brown rather narrow band or shade across the middle of both wings. In addition to this dark median band or shade a usually prominent marking of this species is the presence of a small irregular whitish patch located in subapical area of both wings. In some specimens these patches are not so conspicuous but form part of a lighter brown area lying between the dark irregular median band or shade and row of small dark brown or blackish spots which lie between the two marginal metallic lines.

There are two marginal metallic lines across both wings which are leaden or coppery in color, the inner line being heavier and made up of irregular linear markings broken at the veins. The inner line of irregular metallic markings is exserted outwardly near the middle of the wings, while the outer line forms a fine continuous line close to the edge of wing. As already noted, between these metallic lines is a row of very small dark brown or blackish spots. Both the metallic lines and small dark spots are barely discernible on upper surface in the holotype and most of the paratypes. The ground color of the basal half of upper wing surface is of a dark brown shade, while the sub-marginal or limbal area is lighter. The fringe is pale brown, faintly checkered with white at apex, inner angle, and middle of forewing and also faintly checkered with whitish in secondaries, but the checkering varies considerably in some specimens being more prominent than in others. The outer edge of forewing of the male is slightly undulated, the tip being squared off and pointed.

The lower wing surface, including legs, thorax and abdomen is of a uniform ochre color and the dark median shade and the contrast in brown and whitish colors of the upper wing surface is entirely lacking.

On the lower surface the markings of the upper surface are repeated and well-defined due to the lighter uniform ground color. The two metallic marginal lines are silvery in color and quite prominent, the inner line is particularly heavy and exserted at the middle, while the outer marginal line is fine and straight. There are three very fine, small and barely discernible metallic lineal spots along the costal wing margin near the inner metallic line. The small dark spots between the two marginal metallic lines are usually small and faint in most specimens.

Female allotype: Primary wing expanse 27 mm., forewing 14 mm. (about average for nine other specimens examined). It is similar to the male in general markings and coloration on both surfaces. The whitish checkering of the fringes is usually more noticeable in the female. The forewings of the female are not so pointed as in the male but are more rounded and becoming square cut at the apex.

The new species *C. arizonensis* was mistakenly figured as *C. nemesis* in Holland's Butterfly Book, 1898 Edition, Plate 28, Fig. 14. Holland identifies this figure as *Calephelis nemesis*. I have carefully examined the specimen from which this photo was made (in the Edwards collection at Carnegie Museum) and have made a genitalia slide of it and find that it is *C. arizonensis* and not *C. nemesis* or *australis*.

In Holland's 1931 edition this same specimen of *C. arizonensis* is shown on Plate 8, Figure 14 as *C. australis*. Although the size is the same and the markings and coloration of the upper wing surface in this specimen are not quite so well defined as in type *C. arizonensis*, still they are fairly discernible and identifiable as *C. arizonensis*. There may be hybrids between *C. arizonensis* and *C. nemesis*, as I have seen some specimens that appear to be that, both superficially and in their genitalia.

The holotype and allotype of *C. arizonensis* will be deposited in the U. S. National Museum with permission of Dr. J. W. Tilden, original collector and owner, and paratypes of same will be deposited in Los Angeles County Museum, Carnegie Museum, American Museum and in some private collections with permission of the owners. Genitalia slides or preparations if made, will be deposited with the specimens.

No. 17 **Calephelis sinaloensis,** McAlpine, new species

Male holotype primary wing expanse 20 mm., forewing 12 mm., (about average for the seventeen male specimens examined, although three of these specimens were about 23 mm. in wing expanse). The holotype and a number of the other male specimens in this series were taken on Nov. 1, 1961, 17 miles east of Concordia, Sinaloa, Mexico, by the Cary-Carnegie Expedition.

The upper wing surface of holotype is of a uniform dull rather dark chocolate brown color with all markings rather subdued. The usual four or five concentric rows of small black broken markings are present on the basal half of the wings, but are not easily discernible. The outer of these basal lines is somewhat heavier than the others and slightly shaded inwardly forming a slight narrow and irregular not very distinct dark band across both wings, varying considerably in the specimens at hand. Beyond this outer basal line or band are the usual two fine silvery lines, submarginal and marginal, between which is a row of small black dots. The fringes are pale brown whitish or checkered with white. Antenna and club blackish with white checkering at joints. Thorax and abdomen blackish.

The lower surface is a uniform ochre or yellowish slightly reddish brown with all markings of the upper wing surface repeated but more clearly defined because of lighter ground color. The outer basal black irregular line is mostly single but inclined to be doubled in the holotype. The two silvery lines and black dots between are well defined. The submarginal silvery line of

broken spots is not so exserted at the center of wings as in some other species of Calephelis.

Female allotype, primary wing expanse 20 mm., forewing 12 mm., (about average for seven specimens in the series examined). The shape of the primary wings of the female are decidedly rounded while in the male it is more slender and the apex more pointed. The color and markings of the upper wing surface are quite similar to the holotype but the markings are somewhat heavier and the outer basal line of black markings, together with some dark shading, is a little better defined than in the male. The lower wing surface is the same color as in the male and all lines and markings are quite heavy and well defined. The outer basal broken line is single in the allotype but in some other specimens in the series it is somewhat doubled. The female allotype and others in the series were taken at Mazatlan, Sinola, Mexico on Oct. 28, 1961. Nothing is known of the life history of this species. *C. menesis* was found in company with it. The genitalia of both male and female are quite distinctive as indicated in the drawings. The genitalia of both male and female of *C. sinaloensis* is quite similar to genitalia of *C. arizonensis* the only other species it might be confused with. *Calephelis arizonensis* is a much larger butterfly usually with lighter shades of brown on both surfaces than in *C. sinaloensis.* The black markings are heavier on *sinaloensis* although the median shaded area on the upper surface is better defined in *arizonensis.* The upper wing surface of *C. sinaloensis* lacks the striking small whitish subapical area on both wings present in typical *arizonensis.*

The distribution as indicated by specimens at hand in the series is central Sinaloa, Mexico, near Mazatlan and Concordia.

The holotype and allotype will be deposited in the Carnegie Museum and paratypes in U.S.N.M. and some other museums with permission of owners, together with genitalia preparations of same.

No. 17A **Calephelis sinaloensis nuevoleon,** McAlpine, new sub-species

Male holotype, primary wing expanse 25 mm., forewing 12 mm. There was one other male a paratype of same size. The holotype is a fresh specimen taken at Iturbide, Nuevo Leon, Mexico on Aug. 16, 1965, by W. S. McAlpine. The male paratype was taken on Aug. 13, 1947, at Nombre de Dios, Durango, Mexico, Elev. 5900 ft. by W. Gertsch and M. Cazier for the American Museum.

The upper wing surface of holotype is of a uniform slightly reddish dark brown color with the usual four or five concentric rows of small black broken markings present on basal half of the wings. There is a trace barely discernible of a narrow median dark shade across both wings just inside the outer basal line of black markings.

The usual two silvery fine lines, submarginal and marginal are present and well defined, being rather prominent, and the small black dots between the silvery lines are well defined. The fringes are light brown, slightly checkered with whitish. The antenna are blackish with white checkering at the joints, and yellowish at tip of club. Thorax and abdomen dark brown.

The lower wing surface is of a uniform ochre or yellowish slightly reddish brown color, with all markings of the upper wing surface repeated and clearly defined. The outer basal line of black markings is single. The two silvery lines and black dots between are well defined and prominent.

The other male specimen, which was made a paratype is a rather wore specimen, slightly lighter in color on both surfaces but with markings very similar to the holotype, only not so prominent on the upper wing surface, and with genitalia identical with holotype.

The female with genitalia figured, was taken in the State of Durango, the same State where the above paratype was taken and is assumed to be probable female of this species. This female, has primary wing expanse of 22 mm., forewing 11 mm. It was the only female taken and agrees well with general markings of the holotype only these markings are not so prominent on the upper wing surface. The fringes are light brown and well checkered with white.

This sub-species appears rather closely related to both *C. arizonesis* and *C. sinaloensis,* but seems closest to *C. sinaloensis,* so have designated it as a sub species of *C. sinaloensis.* It is to be noted that in the male genitalia of both *C. sinaloensis* and its sub species *nuevoleon* the end of the transtilla is nearer the end of the valvae than in *C. arizonensis* and that the bristles or armature at end of valvae extend further down on the inside of valvae in *C. sinaloensis* and its sub species than in *C. arizonensis* and that end of valvae is more square cut in *C. arizonensis.*

Life history work is desirable in these two species and the sub species to determine their relationship. The range of this sub species, as determined by the two male specimens in the series, is State of Nuevo Leon and Durango, Mexico, which adjoins State of Sonora.

The holotype will be deposited in the U. S. National Museum and the male paratype and female from Durango will be deposited in the American Museum.

No. 18 **Calephelis dreisbachi** McAlpine, new species

Male holotype primary wing expanse 23 mm. The series included six male specimens which ranged from 20 mm. to 23 mm. in primary wing expanse. The holotype and four male specimens of the series obtained from R. J. Jae, were collected by the R. R. Dreisbach of Midland, Michigan, at San Blas, Sinaloa, Mexico, on Sept. 13, 1957. One other male, also obtained from R. J. Jae and similar to the holotype was taken July 3, 1956 by R. R. Dreisbach at San Blas, Mexico, no state mentioned.

Two other male Calephelis specimens in my possession were taken July 7, 1963 by J. P. Donahue, then of Michigan State University, at about four miles east of San Blas, Nayarit. These specimens were evidently a summer form which varied a little from the other male specimens of *C. driesbachi* in having the markings on the upper wing surface heavier and more clearly defined. San Blas, Nayarit is about 400 miles south of San Blas, Sinaloa, Mexico, type locality of *C. dreisbachi.* There is some doubt as to whether these two specimens are *C. dreisbachi* or *C. montezuma* as males of these two species look quite alike and no females were taken at the time to clarify identification as the females of these species are entirely different.

Upper surface of holotype is uniform rather dark reddish brown with all markings not very well defined and somewhat rubbed. The usual four or five concentric basal irregular and broken lines of black markings are discernible, the outer of these lines being slightly heavier with a shaded area, near upper primaries. This small shaded area is not noticeable in the other male specimens and is not present in the summer form. Beyond the outer median black basal line are two rather fine silvery lines with a row of small black dots between. The sub marginal or inner silvery line is somewhat irregular and broken at the veins while the marginal silvery line is straighter and parallels the outer edge of wing. The fringes of the holotype and the other male specimens are worn but appear to be light brown with white checkering. The lower wing surface is uniform ochre light yellowish brown, with all markings of the upper wing surface repeated and well defined. The outer basal line of black markings is single and not doubled.

Female allotype primary wing expanse 23 mm. This a rather badly battered and worn specimen obtained from R. J. Jae and collected by R. R. Dreisbach at San Blas, Sinaloa, Mexico on Sept. 13, 1957, same date and place as the holotype. One other female was collected by Killian Roever on July 19, 1961 along Route 93 six miles north of Nogales, Santa Cruz Co., Arizona. This is a very good specimen and is made a paratype as most markings and the genitalia are similar to the allotype. In the allotype, the shape of the primaries are more square cut or rounded than in the male, where they are narrower and more pointed at the apex. The upper surface is a rather dark shade of brown badly worn off, but the assumed paratype is much fresher. On the upper surface are traces of a dark shade or band across both wings, this being more evident in the paratype. There are the usual two metallic lines, sub-marginal and marginal, leaden in color, with a row of small black dots between, but all are barely discernible.

The lower wing surface of allotype is uniform ochre color, slightly lighter and more yellowish than in the holotype. All markings of the upper surface are repeated and fairly well defined and there is no doubling of the outer basal line of black markings although there is doubling of this line in places on the assumed ♀ paratype taken at Nogales. The sub-marginal silvery line is much heavier in the primaries than the marginal line. The fringes are worn off in the allotype but are light brown checkered with white in the assumed paratype taken at Nogales.

The genitalia of allotype and of assumed female paratype, taken at Nogales are similar, and are distinct from other Calephelis genitalia.

Due to lateness in getting the complete Revision to the printer, the photo of the allotype of *C. dreisbachi is* shown at end of photos for genus.

The male genitalia of *C. dreisbachi* is quite similar to male genitalia of *C. montezuma* but the transtilla is longer and more curved at the end in *C. montezuma,* and careful comparisons show other differences.

No other specimens of *C. dreisbachi,* except the one female taken by Roever, have been collected at Nogales, Arizona, although some collecting has been done there since 1961. I have seen no other specimens of *C. dreisbachi* taken in Mexico between Nogales, Arizona and San Blas, Sinaloa, Mexico, a distance of about 400 miles, so it is possible that the assumed ♀ paratype specimen taken by Killian Roever in 1961 was accidently trans-

ported to Nogales which is the main entry and exit port between Western Mexico and the United States.

The holotype and allotype will be deposited in the U.S. National Museum and paratypes elsewhere, with permission of R. J. Jae and Killian Roever.

No. 19 **Calephelis stallingsi** McAlpine, new species

Mr. Don Stallings and Dr. Turner of Caldwell, Kansas, have been very generous and cooperative in supplying Calephelis material, especially from Mexico. In the course of examination of this material a little species, somewhat similar to *C. perditalis* or *C. virginiensis* in general appearance and size was uncovered which apparently represents an undescribed species. There are several broods of this species during the year and the upper surfaces of the summer forms are rather dark dull reddish brown with white checkered fringes and fine silvery metallic lines, while the upper surfaces of the winter forms are rather drab brownish with a narrower irregular dark brown transverse band or shade across the middle of both wings, with fringes that are not so noticeably checkered as in the summer forms, and with fine hardly discernible lead colored metallic lines. The author proposes the name *Calephelis stallingsi* for this species. The following descriptions are of the holotype and allotype which represent the summer form.

Male holotype was taken at Valles, San Luis Potosi, Mexico, on May 31, 1951 by Stallings and Turner. Expanse of primary wings 22.0 m.m., forewing 12 m.m. Average expanse of primary wings of 17 paratypes 20.8 m.m. Largest 23.0 m.m., smallest 18.0 m.m.

Upper surface: head — eyes, dark brown, front and palpi tawny yellowish, antennae black with white rings at joints, club black. Thorax and abdomen dark brown approaching black.

Upper surface dull rather dark reddish brown, the area between and adjoining the two outer fine silvery metallic lines reddish brown. On the basal half of both wings there is a series of dark brown or blackish linear markings not well defined which are convex to base of wings and which form four or five indistinct and irregular transverse lines across the wings more or less concentric with base, the outer or median transverse line being a little heavier than the rest. Beyond this outer transverse line are two very fine silvery metallic lines between which is a row of small black dots. The outer

metallic line is rather fine, continuous, close to and equidistant from the edge of the wing, while the inner-metallic is heavier, irregular, broken at the veins, and considerably exserted outwardly at the middle of both wings. The fringe is pale brown uniformly checkered with white and pale brown on both wings, some of the paratypes being more distinctly checkered than the holotype. As can be noticed in the wing venation drawing, the outer edge of the forewing is somewhat undulated, being rather square cut at center, with top being pointed and very slightly falcate.

Lower surface: The legs and lower surface of wings, thorax and abdomen are of a fairly uniform pale fulvous color, although the basal part of wings and legs, thorax and abdomen are paler. The basal black markings which correspond to the transverse lines of the upper surface are rather fine, the outer line being slightly heavier. The silvery lines of the upper surface are repeated, but somewhat heavier, the inner line being heavier than the outer and edged with a few dark scales. The inner silver line of the forewing is exserted outwardly near the middle, but not quite so much as in *virginiensis*. There are a couple of very fine metallic silver specks along the costa preceding the inner metallic line. The black dots between the two metallic lines are repeated on the underside. All of the markings of the lower wing surface are more distinct and prominent than on the upper wing surface. There is a tendency for doubling of the outer or median transverse line on basal half of wings.

Female allotype was taken at Tamazunchale, San Luis Potosi, Mexico, on June 7, 1951, by Stallings and Turner. Expanse of primary wings 22.0 m.m., forewing 12 m.m. Average expanse of primary wings of four paratypes 21.6 m.m. The upper surface is more uniform lighter reddish brown with more definite and heavier markings than in the male. The fringes are light brown, with prominent white checkering on both primary and secondary wings. The outer edge of wing primaries is more square cut and not so pointed as in the males as is usually the case in Calephelis. The lower surface is similar in color to the males with metallic markings and black dots between, somewhat heavier and more prominent. The outer or median transverse line on basal half of wings is single.

Among the specimens of typical *C. stallingsi* that Stallings and Turner collected were thirteen specimens from Valles, San Luis Potosi, Mexico. Eleven were males and two females, and two specimens from Tamazunchale, San Luis Potosi, one male

and one female. They also collected three males at Huichihuayan, San Luis Potosi, and two other males and one female, poor specimens, from the same locality.

Stallings and Turner also collected ten specimens of the winter form of *C. stallingsi* at Victoria, Tamaulipas State, 3 at Valles, 1 at Cd. Mante, San Luis Potosi State, and 1 near Mexico City. Two other badly worn males were from Cd. Mante and one badly worn female from Valles were also collected by Stallings and Turner. The paratype series as a whole are not very perfect specimens.

C. stallingsi seems to resemble forms of *C. perditalis* and *C. virginiensis.* The summer and winter forms of *C. perditalis* and *C. stallingsi* seem to resemble each other quite closely in color and markings and are about the same size, except that the fringes are decidedly checkered in *C. stallingsi* while little or no checkering is present in *C. perditalis.* The winter forms of both species are quite similar with very little checkering of the fringes in *stallingsi* and none in *perditalis.* On the lower wing surface the outer transverse basal line of *perditalis* is usually inclined to be doubled while this is not usually so in *C. stallingsi,* although the holotype and some of the paratypes of *Calephelis stallingsi* winter form have tendency for doubling of this line as in *C. perditalis.*

The primary wings of male of *stallingsi* are inclined to be more pointed than in male *perditalis* and the edge of the wing is more undulated in *stallingsi.* The upper wing surface of *C. virginiensis* is more of a lighter and brighter uniform reddish brown color than in *C. stallingsi.* It is easy to mistake specimens of this species for some forms of *C. perditalis* or other closely related Calephelis so it becomes necessary to examine the genitalia, to be certain of identification. The male genitalia of *C. stallingsi* are very distinct and easily separated from other species of the genus by the large extended and angulated transtilla, and small rather pointed ends of the valvae with little armature. The female genitalia of *C. stallingsi* are also quite distinct as indicated in the drawings of the genital plate.

The range of *C. stallingsi* from specimens at hand, appears to be eastern Mexico, along the gulf coast, from Victoria south into British Honduras and Guatemala.

In addition to Mr. Don Stallings and Dr. Turner the author is indebted to Mr. S. C. Thompson of San Antonio, Dr. G. W.

Rawson, E. C. Welling, the late R. R. Dreisbach and R. J. Jae for specimens, and to Dr. J. F. Gates Clarke and William Field of the U.S. National Museum for aid in identification and loan of specimens.

Specimens of *Calephelis stallingsi* have also been received from Dr. G. W. Rawson, from Tamazuanchal, San Luis Potosi; from E. C. Welling, from Tepescuintle, Tabasco State, Mexico, and X Can Quintana Roo and Piste Yucatan, Mexico, and also one specimen from British Honduras and two specimens from Guatemala. Also received one specimen from Guatemala from the British Museum. Also received from U.S. National Museum one specimen from Cordoba, Veracruz, and one specimen from Tuxtepec, Oaxaca, Mexico; one specimen from R. R. Dreisbach from Puente National, Veracruz, Mexico and one specimen from R. J. Jae (M. Spellman Coll.) from Catemaco, Veracruz, Mexico. *C. stallingsi* appears to have quite an extensive range from northern Mexico southerly to Honduras in Central America.

In addition to the type series of 34 specimens, there were 38 other specimens obtained from various localities previously referred to, but some of these specimens were not in very good condition. Paratypes have been made of the better specimens and they will be returned to those from whom they were received. The male holotype and female allotype will be deposited in the U.S. National Museum and paratypes will be distributed to other museums and collectors with consent of the owners.

No. 20 **Calephelis matheri** McAlpine, new species

Male holotype, expanse of primary wings 20 mm., forewing 12 mm., which was average of four male specimens in the series all of which were examined and genitalia slides made. Three of these specimens including the holotype were taken on Nov. 25, 1965 and the other one was taken Dec. 1, 1965 at San Jose Purua, Michoacan, Mexico, by Bryant Mather and sent to me for study and identification by Harry Clench of Carnegie Museum. Upper surface is of a rather uniform rather dark brown with all markings not very discernible. The usual four or five concentric lines of small black broken markings are present on the basal half of the wings but are barely discernible on the upper surface but can be seen on the lower surface. The outer of these lines is doubled on the holotype and slightly shaded inwardly to form a rather faint and narrow irregular

dark median shade across both wings. In the other three male specimens this outer basal line is perhaps only inclined to be doubled and is slightly shaded inwardly. Beyond this outer basal line are the usual two fine silvery lines, submarginal and marginal, only barely discernible, between which is a row of black spots which is fairly well-defined. As susual the submarginal silvery line is heavier than the marginal one, is irregular, and broken at the veins, and somewhat exserted at the middle of the wings, while the marginal silvery line is straight, not broken, and parallels the edge of the wings. The fringes are light brown checkered with whitish. The antenna are blackish, checked with white at the joints and yellowish at tip of club.

The lower surface is uniform ochre or light yellowish brown with all markings of the upper wing surface repeated but much more distinct and well defined. The doubling of the outer basal line of dark markings is well defined in the holotype.

Female allotype, expanse of primary wings is 20 mm. It was taken with the holotype on Nov. 25, 1965 at San Jose Purua, Michoacan, Mexico, by Bryant Mather. There were three other female specimens in the series taken by Mather in the same locality on the same date, which average the same size in wing expanse and all looked similar superficially and with very similar genitalia. The shape of the primary wings of the female are more rounded and square cut than in the male, where they are narrower and more pointed at the apex. The color and markings of both wing surfaces are similar to the holotype. The doubling of the outer basal line is not so well defined in the female allotype, although the tendency for doubing is present and does occur partially.

The male genitalia of *C. matheri* are quite constant but might be confused with *C. perditalis*. The transilla in *C. matheri* is slimmer than in *C. perditalis* and its end extends constantly almost to the end of the valvae, while in *C. perditalis* the transtilla is broader at its base and is constantly much shorter than in *C. matheri*. The female genitalia of *C. matheri* is quite distinctive in type locality, but varies considerably in other localities as shown in the figures. The female genitalia of *C. perditalis* is also quite variable as shown in the figures. The probable range of *C. matheri* is through central Mexico in States of Michoacan, Guerrero, Jalisco, Zacatecas and adjoining areas.

Nothing is known of the life history of *C. matheri* and the females as shown are assumed to be correct because of similarity to the male and being collected on the same date and in the same locality as the males.

The holotype and allotype will be deposited in the Carnegie Museum together with genitalia slides of same. Paratypes will be deposited in U.S.N.M. and other museums and private collections by direction of the owners.

No. 21 **Calephelis huasteca** McAlpine, new species

The basis for this species is a series of three female specimens taken at or near Tamazanchale, San Luis Potosi, Mexico by three different collectors during the summer season. These specimens appear to be alike both superficially and in genitalia and are somewhat different from other known species. It has been difficult to definitely determine the male of this species but two male specimens collected at Tamazunchale by H. A. Freeman, about one year later at the same locality where the above females were taken could be of this species. The three female specimens above referred to were not very good specimens, one collected June 6, 1941 by Stallings and Turner was considerably worn with lighter brown color on upper surface with expanse of primary wings 20 mm., second of the specimens was collected by H. A. Freeman on July 18, 1963 was also a badly worn specimen with a lighter brown color on upper wing surface, with expanse of primary wings about 20 mm., the third specimen was collected by J. P. Donahue on August 3, 1963 with wings considerably mutilated but being a fresher specimen with blackish brown color on upper wing surface.

The two male specimens, collected by H. A. Freeman which could be the male of this species are fresher and darker in color and quite similar to the third female specimen in coloration. These two male specimens were both collected on June 19, 1964 at Tamazunchale, at the same locality as the females were collected, only about a year later, one specimen had expanse of primary wings of 20 mm. and the other one 22 mm.

Female allotype. The female allotype was selected as the specimen collected by H. A. Freeman on July 18, 1963 at Tamazunchale, Mexico with primary wing expanse of 18 mm., forewing 10. mm.

As before stated it is a rather worn specimen. The upper surface is uniform light chocolate brown with the usual mark-

ings present but only barely discernible. There are traces of a narrow and irregular median dark band located at the usual outer basal line of dark markings. The lower wing surface is pale yellowish ochre with all the markings of the upper wing surface repeated, but well defined. The outer basal line of black markings is decidedly doubled and the two usual silvery lines are present, between which is a row of rather small dark spots. The fringes are worn off, but in the other two female specimens they are light brown checkered with white. Figures of the genitalia of the allotype and one of the other females are shown and appear to be nearer to *azteca* than to any of the other species. Superficially both *huasteca* and *azteca* are quite similar but *azteca* appears to be a somewhat larger species.

Male holotype. The two male specimens collected by H. A. Freeman are assumed to be the male of the females, which they resemble superficially both in markings and in size. The specimen selected as holotype has primary wing expanse of 20 mm., forewing 11 mm. The upper wing surface of the holotype is of a rather uniform dark blackish chocolate color with the usual black basal markings and the two fine silvery lines, between which is a row of black dots, none of which are very distinct. There are traces of a narrow and irregular median dark band along the outer basal line of dark markings as in the female specimens. The fringes are brown checkered with white and the antennae are black with white at the joints.

The lower surface is rather light reddish ochre with all the usual markings of the upper wing surface repeated and well defined. The outer basal line of black markings is decidedly doubled as in the female.

Figures of the genitalia of the holotype and the other male specimen are shown and appear to be alike and somewhat different from others. The shape of the valvae and shorter length of the transtilla, and shape of the aedeagus are somewhat different from those of *C. azteca.*

The allotype and holotype will be deposited in the U.S. National Museum with consent of the original collectors.

No. 22 **Calephelis montezuma** McAlpine, new species

Male holotype, expanse of primary wings 21 mm., forewing 11 mm. which was close to average of thirty male specimens examined. The holotype with a number of other specimens of this species were taken by me on September 23, 1966 at Ciudad

Valles, and Tamazunchale, San Luis Potosi, Mexico. The upper surface of holotype is uniform chocolate brown with all markings indistinct. The usual four or five concentric rows of small black broken markings are present on the basal half of the wings, but are only discernible on close examination, the outer of these basal lines being somewhat heavier and shaded to form an indistinct and narrow irregular dark band across both wings. Beyond this band are the usual two very fine silvery lines, submarginal and marginal between which is a row of black spots, which are more discernible. The submarginal or inner silvery line is slightly heavier and irregular and broken at the veins and somewhat exserted outwardly at the center of the wings but not so much as in *C. virginiensis* and some others, while the marginal or outer silvery line is fine, fairly straight and paralleling the edge of the wing. The fringes are concolorous with the upper surface and are checkered with white. The antennae with club are blackish with white checking at the joints, and the head, thorax and abdomen are concolorous with the upper wing surface. The lower wing surface of the holotype is uniform light ochre or reddish brown with all markings of the upper wing surface repeated, but much more distinct and better defined. The outer basal line of black markings is single and not shaded. Some of the specimens in the series are somewhat darker or blackish shade of brown on the upper surface.

Female allotype, expanse of primary wings 20 mm., forewing 11 mm. is a small specimen, as the average size of the fourteen female specimens examined is about 22 mm. The shape of the primary wings are more rounded and square cut than in the male, where they are narrower and more pointed at the apex. The color and markings are the same as in the holotype, except that all the markings are heavier and more discernible. The white checkering and silvery lines are fairly well defined on the female. The submarginal silvery line is very much heavier on the lower surface of the female, than in the male. The female allotype was taken by me at Ciudad Valles, San Luis Potosi, Mexico on September 22, 1966 in copula with the holotype.

The genitalia of both male and female are distinctive from other species of Calephelis as shown in the figures. Some figures of genitalia somewhat similar to holotype and allotype are shown of other specimens from the same locality.

The male genitalia looks somewhat like those of *azteca* but the valvae are shorter and the transtilla is longer, and more

curved at its end in *montezuma* but the female genitalia of these two species are entirely different. The male genitalia of *C. montezuma* also looks somewhat like *C. dreisbachi,* but the female genitalia of these two species is entirely different. *Calephelis montezuma* flies in company with several other species of Calephelis. This makes identification difficult, as they all look much alike in a general way, and only careful genitalic examination can determine the species. Nothing is known of the life history of *C. montezuma.*

As indicated by specimens at hand this species appears to range in Mexico from Ciudad Valles and Tamazunchale, San Luis Potosi, west possibly to San Blas, Nayarit, and south to Fortin de Las Flores and Acayucan in Vera Cruz.

The holotype and allotype with some paratypes will be deposited in the U.S. National Museum and other paratypes will be distributed to Mexican National Museum, Carnegie Museum, American Museum, Los Angeles Museum and British Museum and some others, as well as to some collectors, with consent of the owners.

No. 23 **Calephelis acapulcoensis** McAlpine, new species

Male holotype primary wing expanse 24 mm., forewing 12 mm. There were seven male specimens in the series, and genitalia slides have been made of the abdomens of all. They vary in wing expanse from 20 mm. to 24 mm., most being about 24 mm. The male holotype and the complete male and female series was taken at Acapulco, Guerrero, Mexico, on June 4, 1962, on low vegetation on edge of jungle growth at altitude of 23 ft. by Dr. G. W. Rawson.

The upper surface of the holotype is rather uniform dark brown, inclined to be blackish on basal half of the wings due to the usual four or five concentric rows or lines of black broken markings. The outer of these basal lines is shaded slightly inwardly to form a not very discernible median shade across both wings. Beyond this median shade the basic color of wing is of a slightly lighter reddish brown. In this area are the usual two fine silvery lines, submarginal and marginal between which is a row of small black dots. All markings on the upper wing surface are indistinct, the silvery lines being more noticeable. The inner or submarginal silvery line is irregular, broken at the veins and exserted at the center of the wing, while the marginal silvery line is straight, not broken,

and parallels the edge of the wing. The fringes are light brown, and whitish, being checkered with white. The antenna are blackish with white at the joints and yellowish at tip of club.

The lower surface is of a uniform light reddish brown, somewhat darker in color than *C. matheri.* All markings of the upper surface are repeated and well defined except that in the submarginal line of silvery spots in the primaries in some places, these spots are small and very faint. The outer basal line of black broken spots is single and not shaded in the holotype but is doubled in one of the males in the series.

Female allotype primary wing expanse 24 mm., forewing 12 mm. Only one other female was taken, wing expanse 21 mm. Both specimens are badly worn but markings are fairly well defined. Both female specimens were taken at Acapulco, State of Guerrero, Mexico on June 4, 1962 by Dr. G. W. Rawson on the same date and in same locality where the holotype and other male specimens in the series were taken. The basic color of the upper surface of the allotype is uniform rather light reddish brown, lighter than in the holotype but some of this lightness in color is probably due to wear. The shape of the primaries of allotype are more rounded and square cut at the apex than in the male, where it is narrower and more pointed at the apex. The markings on both wing surfaces are similar to the holotype but heavier. These markings are more discernible on the upper surface ofthe female than in the male due to the lighter ground color. There is no median shade across the wings on the upper wing surface of the allotype.

The lower surface of the allotype is of a lighter more yellowish brown than in the holotype and all markings are well defined except where worn off. The outer basal line of black spots is well defined and single. The fringes are worn off on the allotype, but the antennae are same as in the holotype. Nothing is known of the life history of this species.

The male genitalia of *C. acapulcoensis* are somewhat similar to those of *C. yucatana* and *C. matheri* but the female genitalia of all three are different from each other as indicated in the drawings. The holotype and allotype together with genitalia slides will be deposited in the U.S. National Museum and some paratypes elsewhere with consent of Dr. Rawson.

No. 24 **Calephelis azteca** McAlpine, new species

Male holotype expanse of primary wings 21 mm., forewing

12 mm., which is about average for twenty-eight male specimens examined. The holotype was taken on May 21, 1965 at Fortin de los Flores, State of Vera Cruz, Mexico, by Dr. G. W. Rawson.

The upper surface is uniform blackish brown, quite similar in color to *C. montezuma,* and the butterfly as a whole resembles *montezuma.* Most of the other male specimens in the series of *C. azteca* are a little lighter brown shade of color than the holotype. The usual four concentric irregular lines of small black markings broken at the veins, are present on the basal half of the wings, but are barely discernible. The outer of these basal lines is somewhat heavier and shaded inwardly to form an indistinct and irregular rather narrow black band or shade across both wings. Beyond this band are the usual two indistinct very fine silvery lines, submarginal and marginal, between which is a row of small black spots. The submarginal or inner silvery line is slightly heavier and irregular and broken at the veins, and somewhat exserted outwardly, at the center of the wings. The marginal or outer silvery line is finer than the submarginal silvery line and is fairly straight paralleling the edge of the wings. The fringes are brown checkered with white. The antennae are blackish with faint white checkering at the joints. Head, thorax and abdomen are blackish.

The lower surface is uniform ochre or reddish, yellow light brown color with all markings of the upper wing surface repeated, but more distinct. The outer basal line of black spots is not shaded, but is doubled or inclined to be so, and differs in this respect from *C. montezuma,* where it is single. The submarginal or inner silvery line of markings in male *C. azteca* is heavier than in the male *C. montezuma.*

Female allotype, expanse of primary wings 23 mm., forewing 12 mm., which is about average for the eight females that are in the series of specimens. The series of both male and female is composed mostly of imperfect specimens, which is quite usual in Calephelis material not reared. The shape of the primaries is more square cut in *azteca* and not quite so rounded as in *montezuma,* and the tip of primary wings is pointed and inclined to be very slightly falcate. The color and markings of both the upper and lower wing surfaces of the female *azteca* are very similar to those of the male. *C. azteca* is very similar to *montezuma* but there are a couple of noticeable differences in markings, which are more clearly evident

on the lower wing surface. First, the outer basal line is usually doubled or inclined that way in *azteca* while it is single in *montezuma.* Second, the black spots between the two silvery lines are smaller in *azteca* than in *montezuma,* and third, the submarginal or inner silvery line of male *azteca* is decidedly heavier than in *montezuma.* The female allotype was taken at Fortin de las Flores, Veracruz, Mexico, on May 21, 1965 by Dr. G. W. Rawson, at the same locality and date of the holotype, and therefore is assumed to be the female of *azteca.* No life history work has been done with *azteca.*

The male genitalia of *azteca* and *montezuma* are somewhat similar but the transtilla of *montezuma* is longer and more abruptly curved at the end than in *azteca.*

The valvae is longer and with heavier armature in *azteca* than in *montezuma.* The female genitalia are distinctly different in *azteca* from *montezuma* as indicated in the figures. The female genitalia are somewhat like those of *C. huasteca.*

The distribution of *C. azteca* as indicated in the series of specimens at hand, is Fortin de los Flores, Huatusco, Santa Rosa, Orizaba and Jalapa, all in Veracruz, and Tamazunchale and Xilitla, San Luis Potosi, and possibly Victoria in Tamaulipas, Mexico.

The holotype and allotype will be deposited in the U.S. National Museum, and paratypes will be distributed to other museums and collectors with permission of the owners.

No. 25 **Calephelis yucatana** McAlpine, new species

Male holotype primary wing expanse 24 mm., forewing 13 mm. Forty-eight male specimens were examined and genitalia slides or preparations made of all but ten. In this series the primary wing expanse varies from 21 mm. to 25 mm. The male holotype was taken at X-can, Quintana Roo in the Yucatan Peninsula of Mexico, July 19, 1962, by E. C. Welling. Most of the specimens in the series were taken in Quintana Roo and Tabasco and a few at Presidio, Veracruz, Mexico.

The upper surface of the holotype is rather uniform chocolate blackish brown with just a trace of a median darker shade across both wings. Some of the specimens of the series are not so blackish on upper wing surface. The usual four or five concentric lines of small black broken markings are present on the basal half of the wings but are barely discernible except the outer line, which marks the trace of the darker shade across

the wings. Beyond this outer basal line the ground color is a little lighter and the usual two fine silvery lines, submarginal and marginal, are present between which is a row of well defined black dots.

The lower surface is uniform rather light reddish brown with all the markings of the upper wing surface well defined. The outer basal line of black markings is single and not shaded. The fringes are light brown, checkered with white, but not prominently so. The antennae are blackish, with white at the joints, and yellowish at tip of club.

Female allotype primary wing expanse 25 mm., forewing 14 mm., is about average for the eleven female specimens in the series. The upper wing surface is uniform light brown, with all markings fairly well defined and located as in the holotype. The black dots between the two silvery lines are large and prominent. The outer basal line of black markings is well defined and shaded inwardly to form an irregular dark band across the wings which is more discernible than in the holotype. The fringes are light brown checkered with white. The shape of the primary wings is more rounded and square cut at the tip than in the male where it is narrower and pointed and slightly falcate at the tip. The lower surface is uniform pale yellowish brown with all markings of the upper surface repeated and well defined. The black dots between the two silvery lines are prominent. The basal line of black markings are heavier than usual, and the outer of these lines is single and slightly shaded inwardly in some places, and has a tendency for doubling. The female allotype was taken at X-can, State of Quintana Roo, Mexico, on July 8, 1953, by E. C. Welling. Nine of the specimens in the series of eleven were taken in the State of Quintana Roo, Mexico. The female is assumed to be correct because of similarity to the male and the correspondence of date and locality of capture.

The genitalia of both sexes are distinctive as ~~shown in~~ the figures, and quite constant. In the male genitalia the valvae are round and short, with transtilla extending beyond the valvae and well hooked at the end. The female genitalia as figured is quite constant. The known range of this species from specimens I have seen, include the states of Yucatan, Quintana Roo, Tabasco, Oaxaca and Veracruz, Mexico, and also British Honduras and Guatemala.

The holotype and allotype together with some paratypes will be deposited in the U.S. National Museum. Other paratypes

will be distributed to Mexican National Museum, Carnegie, American, and British Museums and some others and to collectors and owners who furnished specimens.

No. 26 **Calephelis maya** McAlpine, new species

Male holotype, primary wing expanse 21 mm., forewing 11 mm. Forty-one male specimens were examined. In this series the primary wing expanse varies from 16 to 21 mm. with average about 19 mm. The male holotype was taken at X-can, Quintana Roo, Mexico, near the border of Yucatan, on June 26, 1963, by E. C. Welling. Most of the specimens in the series were taken in Yucatan, Mexico, at Chichen Itza and Piste.

The upper surface of the holotype is uniform reddish brown with all markings rather heavy and well defined giving this surface a dark appearance. The usual four or five concentric lines of small scalloped black markings are heavy and well defined on the basal half of the wings. There is only a trace of shading along the inner edge of the outer of these basal concentric lines. Beyond this outer basal line are the usual two fine silvery lines, submarginal and marginal, readily discernible, between which is a row of rather large black dots. The submarginal silvery line is scalloped and broken at the veins and not so exserted at the center of the primaries as in some species, while the marginal line is somewhat finer and is close to and parallels the edge of the wing. The whole lower wing surface is light yellowish and reddish brown with all markings of the upper wing surface repeated and well defined. The outer basal line is single with some traces of shading and doubling inwardly. The fringes are pale brown with indistinct white checkering. The antennae are blackish with white at the joints and yellowish at tip of club.

Female allotype primary wing expanse 21 mm., forewing 11 mm. Twenty female specimens were examined, including their genitalia. The allotype was the largest and the other specimens in the series measured from 17 mm. to 19 mm. in wing expanse. The allotype was taken at X-can, Quintana Roo, Mexico at the same locality where the holotype was taken, on June 23, 1963, by E. C. Welling. Nearly all the other specimens in the series were taken at or near Chichen Itza, Yucatan, or X-can, Quintana Roo. The upper surface of the allotype is uniform rather light reddish brown, a little lighter than in the holotype, with all markings somewhat heavier than in the holotype, but

similarly located. The fringes are light brown with white checkering very indistinct. There is no median dark shade across the wings and the outer concentric basal line of black markings at median area is single. The shape of the primaries is more rounded and square cut than the male as usual in most Calephelis.

The outer edge of male primary wing is straighter and not as undulated as in most other Calephelis species. The lower wing surface of allotype is uniform lighter yellowish brown or ochre with all markings of the upper surface repeated and well defined, and the silvery lines and black dots between are especially prominent as indicated in the figures shown. The dates of capture of specimens in the series at hand range from middle of May to early part of January. The genitalia of both male and female are distinctive and constant as shown in the figures. The figures of genitalia of both male and female are made from small paratype specimens, and match the genitalia of the holotype and allotype.

The male genitalia is somewhat similar to those of *C. perditalis* because of the short transtilla, but the female genitalia are distinctly different and constant in *C. maya*.

The known range of *C. maya* from material I have seen includes Yucatan, Quintana Roo, and one specimen from Tabasco, all in Mexico.

The holotype and allotype together with some paratypes will be deposited in the U.S. National Museum. Other paratypes will be deposited in Mexican National Museum, Carnegie, American and British Museums and some others.

No. 27 **Calephelis wellingi** McAlpine, new species

Male holotype primary wing expanse 18 mm., forewing 10 mm. There were fifteen male specimens examined and genitalia slides or preparations made from them. The average primary wing expanse of specimens in the series was 19 mm. with smallest 17 mm. and largest 21 mm. The male holotype was taken at Tepescuintle, Municipio Tenosque, Tabasco, Mexico, 200 m. on Sept. 12, 1962, by E. C. Welling. The specimens in the series both male and female, were taken in Tabasco, Mexico, and in British Honduras, mostly in the fall of the year by E. C. Welling.

The upper surface of the holotype is rather uniform dark chocolate blackish brown, with just a trace of a median irregular narrow blackish shade across both wings. All of the specimens in the series, with the exception of one from Belize District, British Honduras, Nov. 6, 1958, were similar in coloration to the holotype. This one specimen was uniform light yellowish brown with all markings well defined, the silvery ones being especially so. This specimen may be a seasonal form in the area found.

In the holotype and all others in the series the usual four or five concentric lines to the base, of small black linear broken markings are present, but are only barely discernible on the upper surface, except the outer line, which marks the outer edge of the median dark shade caused by the slight inward shading of this line in places. Beyond this outer basal, median broken line of black markings, are the usual submarginal and marginal lines of silver markings, but these are not very discernible on the upper surface. Between the two silvery lines is a row of rather small black dots.

The lower surface of the holotype is uniform light yellowish brown with all markings of the upper wing surface repeated and well defined. The outer basal line of black markings is well defined with traces of inward doubling or slight shading. The submarginal line of silver markings is irregular and heavier than the marginal line and is broken at the veins and slightly outwardly exserted at the center of both wings, while the marginal silvery line is finer and is close to and parallels the edge of the wings. The row of black dots between the marginal and submarginal lines of silvery markings is well defined. The fringes are light brown, checkered lightly with white. The antennae are black with white at the joints and yellowish at the tip of club.

Female allotype, primary wing expanse 20 mm., forewing 11 mm., which is about the average of the nine specimens in the series which varies from 18 to 21 mm.

The upper surface is about the same color as in the holotype, a rather uniform chocolate blackish brown, with all markings indistinct, but present, and arranged as in the holotype. The submarginal silvery line of markings is heavier than in the holotype and the white checkering of the fringes is more prominent. The primary wings of the female are more rounded and square cut than in the male where they are narrower and more pointed at the tip.

The lower wing surface is uniform light yellowish brown with all markings of the upper surface repeated and more prominent. The submarginal silvery line of markings is very heavy. The black dots between the two silvery lines are rather small but well defined. The outer basal line, or median line of black markings is single in the allotype but is doubled or partially so in half of the specimens of the series.

The female allotype was taken at Tepescuintle, Municipio Tenosique, Tabasco, Mexico, 200 meters on October 18, 1962 by E. C. Welling at the same locality where the holotype was taken and is assumed to be the female of the species. The other eight female specimens of the series were taken in British Honduras, mostly at Camp Sibun District, in November of 1958.

The genitalia of both male and female are distinctive as shown in the figures and are quite constant in the type series. The valvae of the male genitalia is rather long and narrow. The transtilla varies slightly in width at posterior end, but is about constant in length, as shown in the two figures of specimens in the series. The female genitalia are distinctive, with but little variation. *Calephelis wellingi* may extend at least into Guatemala, I have a series of Calephelis from Baleu, San Cristobal, Vera Pas, Alta Verapaz, which have similar female genitalia and the general pattern of the male genitalia somewhat similar and general markings and color of wing surfaces also quite similar to *C. wellingi.* This series from Baleu averages 22 mm. in primary wing expanse, considerably larger than average of type series of *C. wellingi.* This series I am calling *Calephelis wellingi baleuensis.* I have also a series of Calephelis from Costa Rica which have female genitalia similar to *C. wellingi* but with male genitalia that differ considerably from *C. wellingi* and am calling this series from Costa Rica *Calephelis browni,* McAlpine, new species.

The holotype and allotype of *Calephelis wellingi* with some paratypes, together with genitalia preparations of same will be deposited in the U.S. National Museum and paratypes will be distributed to the Mexican National Museum, Carnegie Museum, American Museum and the British Museum.

No. 27A **Calephelis wellingi baleuensis** McAlpine, new sub-species

Male holotype primary wing expanse 22 mm., forewing 12 mm. There were fifteen male specimens from Baleu, Mpio

San Cristobal Verapaz, Alta Verapaz, Guatemala, and genitalia slides made from them, in the series. The average primary wing expanse of specimens in the series was about 22 mm., the series varying from 20 to 26 mm.

The male holotype was taken at Baleu, 1350 meters, by E. C. Welling on Aug. 17, 1966. The other specimens in the series were also taken by E. C. Welling, mostly in August, but a few the later part of May and in June and July of the same year. There are three other specimens, two from Panajabal and one from Dept. Solola, Guatemala that appear to be this subspecies.

The upper surface of the holotype is rather uniform blackish brown very similar to the holotype of *C. wellingi* with just a trace of a median irregular narrow blackish shade across the wings, which varies in specimens of the series. The main noticeable superficial difference between this subspecies and typical *wellingi* is the much larger size, of butterfly.

As in typical *wellingi* the usual four lines of small black markings concentric to the base, are present on the basal half of the wings, but are only barely discernible on the upper surface, except the outer line which marks the outer edge of the median dark shade which is caused by the slight inward shading of this line in places. Beyond this outer basal, median broken line of black marking are the usual submarginal and marginal fine lines of silvery markings between which is a row of small black spots, but all these markings are barely discernible on the upper surface.

The lower surface of the holotype is uniform light yellowish brown with all markings of the upper wing surface repeated and well-defined. The two silvery lines of markings and the small black dots between are not so well defined as in typical *wellingi,* and the submarginal silvery line especially is not so heavy as in typical *wellingi.* The outer median basal line of black markings is inclined to be doubled in places but this varies in other specimens of the series. The fringes are brown checkered with white. The antennae are black with white at the joints and yellowish at the tip of the club.

The female allotype was taken on Aug. 13, 1966 by E. C. Welling at Baleu, Guatemala, 1350 meters, at the same locality where the male holotype was taken and at about the same date, and is assumed to be the female of the species. There are eleven female specimens in the type series, all taken at Baleu by E. C. Welling, mostly in the early part of Aug. 1966. Five

other specimens have been examined, two from Panajabal and one from Cayuga, Esquintla and Saboc, LaBoca, all from Guatemala, that appear to be this subspecies.

Female allotype, primary wing expanse 22 mm., forewing 12 mm., about average for the other female specimens in the series. The upper surface of the allotype is of about the same color as the holotype, rather uniform chocolate blackish brown, with all markings present but indistinct, arranged as in the holotype. The median dark shade across both wings is more discernible in the female than in the male series of specimens. The submarginal silvery line of markings is heavier and the fringes are more prominently checkered with white in the female series than in the male series. The primary wings of the female are more rounded and square cut than in the male, where they are narrow and more pointed at the tip.

The lower wing surface is uniform light yellowish brown, with all markings of the upper surface repeated and prominent. The outer basal line or median line of small black markings is single but inclined to be doubled slightly in a few of the specimens of the series.

As shown in the figures, the male genitalia of *wellingi baleuensis* differs somewhat from those of *wellingi* in shape of valvae, but the general pattern is quite similar, and the female genitalia of both are very similar.

There are several Calephelis species or subspecies that occur in Guatemala, often in the same locality, which appear to be closely related and difficult to identify, especially the males. Among these species are *Calephelis argyrodines, costaricicola,* and possibly *perditalis,* also *wellingi* and its subspecies *baleuensis* and *clenchi, browni, yucatana* and *sacapulas.* It is also possible that in this area hybridization is taking place.

Baleu and Quisache in Guatemala are such areas and I have a large series of specimens from these localities. It appears that in these areas Calephelis species are in a state of flux, and with the large number of apparent species concentrated here, more than in any other area I know of, and Guatemala may well be considered the center of distribution of Genus Calephelis.

The holotype and allotype of *Calephelis wellingi baleuensis* with some paratypes will be deposited in the U.S. National Museum and paratypes will be distributed to Carnegie Museum, American Museum and British Museum.

No. 28 **Calephelis sacapulas** McAlpine, new species

Male holotype primary wing expanse 25 mm., forewing 13 mm. The holotype is the only specimen of this species that was obtained and it was taken at Sacapulas, Quiche, Guatemala, 4500 ft. on Aug. 12, 1947 by P. Vaurie for the American Museum. The ground color of the upper surface is a rather light chocolate brown with a prominent, irregular dark shade or band across the middle of both wings. The outer edge of this band is the outer line of four or five concentric irregular broken lines of small black markings on the basal half of the wings. These broken black lines are barely discernible, except the outer line which is well defined and somewhat scalloped in appearance, especially on the secondaries. Beyond this outer median line are the usual two fine silvery lines, submarginal and marginal, which are indistinct between which is a row of small black spots which are rather prominent. The fringes are pale brown with whitish checkering.

The lower surface is uniform ochre with all markings of the upper wing surface repeated and readily discernible. The outer broken line of small black markings on basal half of wings is single and not shaded inwardly or doubled. The submarginal silvery line is not as heavy as usual, and is very irregular, broken at the veins, and almost entirely lacking at the center of the primaries. The marginal silvery line is well defined and rather fine. The edge of primary wings along the upper two-thirds is straight and not undulated as in most species and the tip is squared off.

The genitalia are distinctive as shown in the figure, with a very long and rather slender transtilla that extends a little beyond the end of the valvae. The general appearance of this butterfly with its rather large dark shade or band across both wings, made more prominent by an outward adjoining lighter area, sets it off from other species of Calephelis.

I have corresponded with the American Museum and with Vaurie trying to obtain additional specimens but they have no more. There is always a possibility that the holotype may be a unique specimen.

The holotpe with genitalia slide will be deposited in the American Museum.

No. 29 **Calephelis clenchi** McAlpine, new species

Male holotype primary wing expanse 22 mm., forewing 12 mm. There are four male paratypes in the series with primary wing expanse of 18, 20, and 21 mm. The holotype was taken at Quisache, Mpio Acatenango, Chimaltenango, Guatemala on August 1, 1965 by E. C. Welling at the same locality and at about the same date as the female allotype was taken. Three male paratypes in the series were taken in the same locality on July 23, July 30, and Nov. 20 in 1965 by E. C. Welling and one male paratype in Carnegie Museum, acc. 6540, was taken in Guatemala City, no date. The upper surface of the holotype is rather uniform chocolate brown. The usual four or five lines concentric with the base, of small black broken markings are present on the basal half of the wings but are only barely discernible, except the outer line or median line near the middle of the wings. There is no median dark shade or band across the wings as is found in some species. Beyond the outer basal line are the usual two fine silvery lines the submarginal one being heavier than the marginal, between which is a row of rather small black dots; the fringes are very pale brown, with whitish in places but not prominently. The antennae are black with white at the joints and yellowish at tip of club. The lower surface is uniform rather light yellowish brown or ochraceous with all markings of the upper surface repeated and well defined. The outer basal or median line of irregular black markings is single and not shaded. The two silvery lines are prominent.

The female allotype primary wing expanse 23 mm., forewing 12 mm. Four female paratypes were examined and genitalia slides made, in the type series. The primary wing expanse of the butterflies in the series varies from 21 mm. to 23 mm. The female allotype was taken at Quisache, Guatemala on Aug. 5, 1965 by E. C. Welling and the other females in the series were taken at the same locality from July 23rd to Aug. 3rd, 1965. The female allotype is assumed to be the female of *C. clenchi* as both the male and female specimens of the series were taken at the same locality and at about the same date. Life history work is desirable to fully verify this as other species of Calephelis are found in this same locality.

The upper and lower surfaces of the allotype are about the same color as in the holotype and the markings are similar.

There is not as much difference in primary wing shape of male and female in this species as in some others, it being more like *C. perditalis* in this respect. *C. clenchi* appears to be closest to *C. perditalis.* The genitalia of the male are quite similar to those of *C. perditalis,* but the valvae are more slender and the armature of the valvae is not so heavy as in *C. perditalis.* There are other differences noticeable upon close comparison. The female genitalia of *C. clenchi* are fairly constant and differ from those of *C. perditalis.* The posterior end of the genital plate in the female paratypes vary somewhat from the allotype, in being wider in some specimens. An extreme variation is figured from a specimen taken at Baleu, Guatemala. Other specimens of clenchi, not in the type series were taken as follows: 1 ♀ Baleu, Guatemala, 1 ♀ Zacapa, Guatemala, and 1 ♀ at Pto. del Dialbo, El Salvador.

The holotype and allotype will be deposited in the U.S. National Museum. Two male and two female paratypes will be deposited in Carnegie Museum.

This species was named after Harry Clench of the Carnegie Museum who has been most cooperative and helpful in my work with Calephelis.

No. 30 **Calephelis browni** McAlpine, new species

Male holotype primary wing expanse 19 mm., forewing 11 mm. Nine male specimens have been examined and genitalia slides or preparations made from them, in the series. The average primary wing expanse of specimens in the series was about 19 mm. with largest 21 mm. and smallest 18 mm. The holotype was taken at Turialba, Ais, Costa Rica, 620 meters, May 30, 1946, by H. H. and F. M. Brown. All of the specimens in the male series were taken in Costa Rica, six of which were taken by H. H. and F. M. Brown at type locality.

The upper surface of the holotype is rather uniform dull dark chocolate brown, with traces of a median irregular rather narrow blackish shade across both wings. The usual four or five lines concentric to the base, of small black linear broken markings are present on the basal half of the wings, but are barely visible on the upper surface, except the outer line, which marks the outer edge of the median dark shade, caused by the slight inward shading of this line. Beyond this outer basal median broken line of black markings are the usual sub-

marginal and marginal line of silvery markings, between which is a row of small black dots. The silver markings and black dots are fairly well defined on most of the specimens of the series. The fringes are light brown checkered lightly with white. The antennae are black, with white at the joints and whitish at tip of club. The lower surface of the holotype is uniform yellowish brown with all markings of the upper surface repeated and well defined. The outer basal line of black markings is well defined and doubled in places, but in other specimens of the series this doubling does not occur. The submarginal line of silvery markings is heavier, as usual, than the marginal line, and is straighter near the costa in the primaries, and not so irregular as in *C. wellingi* to which this species is evidently closely related.

Female allotype primary wing expanse 22 mm., forewing 12 mm. There were three female specimens examined and genitalia slides or preparations made from them, in the series.

The other two specimens in the series measured 21 mm. and 18 mm. respectively in primary wing expanse. The upper surface of the allotype is about the same color as the holotype, a rather uniform dark dull chocolate brown, with all markings as in the holotype. However, the black dots between the two silvery lines are larger and more distinct. The primary wings of the female are more rounded and square cut than in the male, where they are narrower and more pointed at the tip.

The lower wing surface is uniform rather light yellowish brown as in the holotype with all markings of the upper surface repeated and well defined, the markings being quite similar to those in the holotype, except that the outer basal, median line is not doubled, which is also true in the other two specimens in the series.

The female allotype was taken at Hda. El Rodeo, Costa Rica, close to the type locality Turrialba and the other two specimens in the series were taken at Turrialba and Juan Vinas, Costa Rica, respectively, and all are assumed to be the females of this species, as genitalia agree in all three specimens.

The genitalia of both male and female are quite distinctive as shown in the figures and are quite constant in the type series. The female genitalia are similar to those of *C. wellingi*. The fact that the male genitalia of *C. browni* differ considerably in general pattern from those of *wellingi*, and that the type

localities of the two are a considerable distance apart, has caused me to consider *C. browni* a distinct species.

I have a large series of Calephelis from several central localities in Guatemala, namely Variedades Such, Muca Such, and Baleu, San Cristobal, Quisache, Acatenango, and several other areas that appear to be quite similar to *C. browni* or *C. wellingi* in general appearance and in genitalia and are hard to separate and definitely identify. It would appear that the Calephelis in this area are in a state of flux, and that hybridization may occur in several of the species and subspecies found here. Among species probably occuring in this area are *Calephelis argyrodines, costaricicola, wellingi* and its subspecies *baleuensis, browni, clenchi, sacapulas, and yucatana,* all of which look very much alike superficially.

The range of *C. browni* appears to be from type locality in Costa Rica south into adjoining Panama and north through Nicaragua, Honduras and Salvador and into Guatemala but more material is necessary to definitely establish this.

The holotype and allotype of *C. browni* with some paratypes together with genitalia preparations of same will be deposited in the American Museum and paratypes will be distributed to the U.S. National Museum, Carnegie Museum and British Museum.

This species was named after F. M. Brown who collected most of the specimens in the type series for the American Museum. In addition, Mr. Brown has kindly checked over my manuscript on Calephelis.

No. 31 **Calephelis schausi** McAlpine, new species

Male holotype primary wing expanse 22 mm., forewing 13 mm. Six male specimens were examined and genitalia slides made of same. Two of these specimens are from Tegucigalpa, Honduras; one from San Pedro Sula, Honduras; one from Honduras, no location, one from Avangariz, Costa Rica, and the male holotype was taken at San Mateo, Costa Rica, in September, and is in the Schaus collection in the United States National Museum. The primary wing expanse in these specimens varied from 20 mm. to 23 mm.

The upper surface of the holotype is dull rather dark slightly reddish brown. The usual four or five concentric rows of black

markings on basal half of both wings are not well defined but blend together, except the outer line which is fairly well defined, but not noticeably shaded inwardly, so there is no median dark shade or band across the wings as is present in many Calephelis species. The usual two silvery lines with small black dots between are present and fairly well defined. The submarginal silvery line is very irregular and broken at the veins and, as usual, heavier than the marginal line which is straight and unbroken. The fringes are pale brown indistinctly checkered with whitish. The antennae are blackish with white at the joints and the tip of the club is yellowish.

The lower surface of holotype is uniform rather light reddish brown or ochre with the black markings and marginal silver line well defined. The submarginal silver line is not well defined and almost entirely wanting at middle of the primaries; in the other paratypes, however, this is not so and all the markings are well defined. The outer basal line of black markings is single and not shaded.

Female allotype primary wing expanse 22 mm., forewing 12 mm. The allotype was taken at Limon Farm, Rda. El Rodeo, Costa Rica, 700 meters, June 14, 1946, by H. M. and F. M. Brown, and deposited in the American Museum.

Three other females were examined and genitalia slides made. They appear to be this species, two are from San Mateo, Costa Rica and one from Chiriqui, Panama.

The assumed allotype appears to have genitalia somewhat different than other known species from that area, so I assume it to be the female of *C. schausi* but future life history work is necessary to definitely determine this.

The upper surface is dull rather dark reddish brown, similar to that of the holotype and the general markings are the same as in the holotype but perhaps a little better defined.

The lower surface is of a uniform ochre as in holotype and all markings are well defined and prominent. The silvery lines are especially so, the submarginal one being very heavy. The white checkering of the fringes is more noticeable than in holotype.

The primaries are a little more square cut in the female than in the male, but it is not so noticeable as in some other species of Calephelis and the male could be mistaken for the female

without genitalic examination. The male genitalia are quite distinctive as shown in the figure with a rather long transtilla, with end or tip curved and circular, more so than in any other species observed. The female genitalia appears to be quite distinctive coming closest to the new species C. *aymaran* from the more southern countries of South America. The apparent range of this species is from Honduras to Panama. This species was named after Wm. Schaus, deceased, of the U.S. National Museum, collector of the holotype and who did outstanding work for many years for the Museum.

The holotype will be deposited in the U.S. National Museum and the assumed allotype will be deposited in the American Museum, while paratypes will be deposited in U.S. National Museum, American, Carnegie and British Museums, with consent of the original owners.

No. 32 **Calephelis guatemala** McAlpine, new species

Male holotype primary wing expanse 25 mm. The holotype was collected in Valley of River Polochic, Hague, Guatemala, Godman-Salvin Collection, 1914-15, and is deposited in the British Museum.

There are seven specimens in the complete type series, four male and three female, all taken within a restricted area in eastern Guatemala. One of the male paratypes is from the Polochic Valley, and the other two from Guazacapan. The holotype is a fair specimen, but somewhat worn. The upper surface is rather uniform dark blackish chocolate brown, with the usual black and silvery markings not very distinct. There are the usual four or five basal concentric lines of black markings, barely discernible, followed by the usual two rather fine silvery lines, indistinct, between which is a row of faint small blackish dots. The outer median basal line of black markings is slightly shaded inwardly, making a faint median dark band or shade across both wings. The fringes are badly worn but remnants indicate they were light brown, slightly checked with whitish. The antennae are brown with white at the joints, not very noticeable. Eyes are light brown, thorax and abdomen dark brown or blackish.

The lower surface of the holotype is rather uniform reddish ochre brown, with all markings of the upper wing surface repeated and well defined. The outer median irregular basal line

of dark markings is inclined to be doubled and slightly shaded inwardly in places. As usual the outer marginal silvery line of markings is fine, connected and straight, while the inner line of silvery markings is heavier, broken at the veins, irregular, and outwardly exserted at the center of the wings.

Female allotype, primary wing expanse 25 mm. It was collected at San Geronimo, Guatemala (probably near head waters of River Polochic) by Champion and is in collection of Godman and Salvin, 1914-15 in the British Museum. One of the female paratypes is from Polochic Valley and the other from Guazacapan. The allotype is a very good specimen. The upper surface of the allotype is of a rather uniform dark blackish chocolate brown, quite similar to color of holotype, with the usual black and silvery markings, not very distinct. There are the usual four or five basal concentric lines of black markings which are indistinct, except the outer one which is heavier and marks the outer edge of a light median band or shade across both wings which is indistinct. The fringes are not worn and are brown about the color of the upper wing surface and prominantly checkered with white. The marginal silvery line is fine, straight, but indistinct, while the submarginal silvery line is irregular and also indistinct. The antenna are dark brown, checked with white at the joints. Eyes are light brown, head, thorax and abdomen dark brown or blackish.

The lower wing surface of the allotype is uniform yellowish ochre brown, a little lighter in color than the holotype, with all markings of the upper wing surface repeated and well defined. The outer median irregular basal line of dark markings is inclined to be doubled and very slightly shaded in places. As usual the outer marginal silvery line of markings is fine, connected and straight. The inner line of silver markings is much heavier, broken at the veins, irregular and outwardly exserted at the center of the wings. The usual black dots between the silvery lines are present but very small.

The genitalia of both sexes are somewhat similar to genitalia of *Calephelis aymaran*, occuring in Peru, Bolivia, Brazil and some other countries in South America. However, the valvae of the genitalia of holotype *C. guatemala* is broader and more rounded and the end of transtilla is more inwardly curved than in *C. aymaran*. The aedeagus of holotype *C. guatemala* is entirely different than that of *C. aymaran* but this does not hold true in other paratypes of *C. guatemala*.

The female genitalia of *C. guatemala* is more variable than female genitalia of *C. aymaran* where it is quite constant. The anterior end of genital plate is not so thick and is more angular than in *aymaran*. The signum appears to be larger in allotype *guatemala* than in *aymaran* although *aymaran* is a larger insect. The female genitalia of *C. guatemala* as shown in the drawings is assumed to be genitalia of the female of the species, as the females were taken in about the same locality as the males.

The holotype and allotype, and paratypes, together with their genitalia, will be deposited in the British Museum. Paratypes will also be deposited in the U.S. National Museum with consent of British Museum, original collectors.

No. 33 **Calephelis inca** McAlpine, new species

Male holotype primary wing expanse 24 mm. Thirty male specimens have been examined and genitalia slides or preparations made of them. The primary wing expanse varies from 20 mm. to 24 mm. in this series, the majority being about 21 mm.

The male holotype was taken at Cacagualito, Dept. Magdalena, Colombia, 1500 ft., May, with no year given and is in the Holland Collection at Carnegie Museum. The upper surface of the holotype is uniform pale (though rather bright) reddish brown with the usual black and silver markings well defined. The usual four or five concentric lines of small broken black markings on the basal half of the wings followed by the two rather fine silvery lines between which is a row of rather prominent small black spots. In the holotype the outer basal line is well defined and sightly shaded inwardly showing a trace of a median darker band or shade across both wings. This median dark shade is more evident in most of the other specimens in the series. In most of the specimens in the series the color of the upper wing surface is more subdued pale brown than in the holotype and the markings are not so well defined.

The lower surface is uniform pale orange with all the markings of the upper wing surface repeated and well defined. The outer median basal line is single but slightly shaded inwardly. The fringes are pale brown slightly checkered with whitish. The antennae are blackish with white at the joints.

Female allotype, primary wing expanse 25 mm. Twelve female specimens have been examined, and genitalia slides or preparations made of them. The primary wing expanse varies

from 20 mm. to 25 mm., mostly being about 23 mm. The upper wing surface is uniform rather darkish brown with all the usual markings fairly well defined, but not as well defined as in the holotype. As in the holotype the median dark shade or band is barely noticeable, but the degree of shading of this band varies in other specimens in the series.

The fringes are pale brown with whitish spots that are only barely noticeable on the lower wing surface.

As is usual with most female Calephelis the primary wings are more rounded and square cut at the tip, while in the male they are narrower and more pointed.

The lower surface of the allotype is uniform pale orange as in the holotype with markings of the upper wing surface repeated but much more discernible than on the upper surface. The two silvery lines are particularly prominent, the inner one being much heavier than the marginal line. The median outer basal line of black markings is single and not shaded inwardly.

The allotype was taken at Cacagualito, Dept. Magdalena, Colombia, 1500 ft., May, with no year given and is in the Holland Collection at Carnegie Museum. The locality is the same as that of the holotype specimen and is accordingly assumed to be the female of the species. Other males and females were taken in the same locality at the same time. The genitalia of both sexes are quite distinctive, as shown in the figures but there is some slight variation, particularly in the males in certain localities. One such occasional variation in male genitalia is a jog in posterior end of the transtilla as shown in the figure. The female genitalia appear to be quite constant. The known distribution of this species as indicated in the series, is Colombia, Venezuela, Trinidad, Panama and adjoining areas of Brazil. Most of the series are from Colombia and Venezuela.

The holotype and allotype, together with some paratypes will be deposited in the Carnegie Museum. Other paratypes will be deposited in the United States National Museum, American Museum, British Museum and some others who supplied specimens.

No. 34 **Calephelis tapuyo** McAlpine, new species

Male holotype primary wing expanse 25 mm. This species is based on two specimens, a male and a female, the latter as-

sumed to be the female of this species because both were taken at Orosi, Brazil in August 1931 by a collector for Albert S. Pinkus and deposited in collection of The American Museum.

The holotype is a very good specimen and the upper surface is rather uniform dark blackish chocolate brown. The usual black and silvery markings are not very distinct, especially the black markings. There are the usual four or five basal concentric lines of black markings, hardly discernible, followed by the usual two rather fine silvery lines, not very discernible, between which is a row of small fine black dots barely visible. In the holotype the outer median basal line is slightly shaded inwardly, making a faint median dark band or shade across both wings. The fringes are light brown checkered with white. The lower surface of the holotype is rather uniform reddish ochre with all the markings of the upper surface repeated and well defined. The outer median irregular basal line of dark markings is single and not inwardly shaded as on the upper surface. As usual the outer marginal silvery line of markings is fine and straight while the inner line of silvery markings is heavier, broken at the veins, irregular and outwardly exserted at center of wings. The antennae are brown, with white at the joints.

The female allotype is a battered and rubbed specimen with primary wing expanse of 25 mm. The upper surface is more of uniform lighter brown than in the holotype, with similar markings as far as can be seen. The lower surface is uniform light yellowish ochre with well defined markings of black and silver, as in holotype. The silvery lines are heavier than on the upper wing surface. The fringes have been worn off.

In the male genitalia of *C. tapuyo* the armature or bristling at end of valvae is not so heavy, and the posterior end of transtilla is broader and not so slender as in *C. argyrodines* and the aedeagus is slightly different shaped in the two species.

The female genitalia are quite similar to that of *C. argyrodines*, but the bursa of *C. tapuyo* is larger with somewhat smaller signum than in *C. argyrodines* although the butterflies are about the same size. Because *argyrodines* does not appear to be established, by any available records, much south of Guatemala it would appear that *C. tapuyo* could well be considered a distinct species rather than a subspecies.

The name Tapuyo is an Indian race of the Amazon River

region mentioned in the "Naturalist on the River Amazons" by Henry W. Bates about 1848 on page 644.

The holotype and allotype with genitalia slides of same will be deposited in the American Museum.

No. 35 **Calephelis aymaran** McAlpine, new species

Male holotype, expanse of primary wings 20 mm. About 135 specimens have been examined, which range from 20 mm. to 24 mm. in wing expanse. The holotype was taken at Rio Surutu, E. Bolivia, 350 meters, March, 1915, by J. Steinbach, C. M. Acc. 5570, and deposited in Carnegie Museum.

The upper surface of holotype has background color of a rather light chocolate brown, overlaid with the usual markings, which are fairly well defined. The usual four or five concentric rows or lines, of small black linear markings are present on basal half of the wings, but are only barely visible. The outer of these basal rows or lines is shaded inwardly to form an irregular blackish median band or shade across both wings, not very prominent in the holotype but more so in some of the other specimens. Beyond this median band are the usual two rather fine silvery lines, submarginal and marginal, which are not very discernible, between which is a row of rather prominent small black dots. The submarginal or inner silvery line is irregular and broken at the veins, and somewhat exserted outwardly at the center of the wing, while the outer silvery line is fairly straight, paralleling the edge of the wing. The fringes are light brown and faintly checkered with white on primary wings, at apex and at intersection of outer and inner margins. The antennae are blackish, with white checking at the joints. The head and thorax are concolorous with or a little darker than upper wing surface. The lower surface is uniform ochre or pale yellowish, reddish brown, with all linear markings of the upper wing surface repeated but more distinct and better defined. The outer basal line of broken black markings in the holotype is single, except for slight doubling at anterior end of primaries, (not true in some other specimens). The submarginal silvery line is much heavier than the marginal silvery line on the lower wing surface.

Female allotype, expanse of primary wings 20 mm. About thirty specimens have been examined, which range from 20 mm. to 22 mm. in primary wing expanse. The wing shape of

both sexes is quite similar and it is difficult to separate them except by genitalia examination. The allotype was taken at Rio Surutu, E. Bolivia, 350 meters, by J. Steinbach and placed in Holland Collection at Carnegie Museum. As the allotype was taken at the same location, and by the same collector, as the holotype, it is assumed to be the female of the species.

The color and markings of both the upper and lower surface of the allotype are quite similar to those of the holotype. Both holotype and allotype genitalia are distinctive as shown in the figures. The male genitalia appears to be quite constant, with but slight variation throughout the range of the species, but the female genitalia appears to be quite variable.

From the considerable material at hand, most of which was supplied by the British Museum and the Carnegie Museum, this species appears to have a wide range of distribution in South America, including Peru, Brazil, Chile, Bolivia, Paraguay, Argentina and probably adjoining areas.

The holotype and allotype together with their genitalia slides will be deposited in the Carnegie Museum together with some paratypes. Also paratypes, with their genitalia slides, will be deposited in the British Museum. Also paratypes will be deposited in the United States National Museum, American Museum and some South American Museums, with consent of the owners who supplied the material.

No. 36 **Calephelis braziliensis** McAlpine, new species

Male holotype, expanse of primary wings 20 mm., which was about average for sixteen specimens examined, that ranged from 15 mm. to 22.5 mm. in wing expanse. The holotype was taken at Cabo, Est. Pernambuco, Brazil, labeled W. A. Forbes, with no date given, and in Godman-Salvin collection 1914-15 in the British Museum.

The upper surface of holotype has background color of a rather light chocolate reddish brown. The usual four or five concentric rows of small black linear markings are present on the basal half of the wings, but are only barely discernible. The outer of these basal lines is shaded inwardly to form a rather broad and well defined dark blackish median band across both wings. Beyond this band are the usual two rather fine silvery lines, submarginal and marginal, between which is a rather prominent row of black spots of markings that run to-

gether somewhat on the upper surface of the primary wings. The submarginal or inner silvery line is slightly heavier, irregular and broken at the veins and somewhat exserted outwardly at the center of the wings, while the marginal or outer silvery line is finer and fairly straight, paralleling the edge of the wing. The fringes are concolorous with upper wing surface and are checkered with whitish. The antennae with club are blackish with white at the joints, while the head, thorax and abdomen are concolorous with or a little darker than the upper wing surface.

The lower surface of the holotype is uniform ochre or yellowish, reddish brown, with all linear markings of the upper wing surface repeated, but more distinct and better defined, due to lighter background. The outer basal line of broken black markings is single, and not shaded. The holotype is a fairly fresh specimen. Most of the specimens in the series are worn, but still conform well with the holotype.

Female allotype, expanse of primary wings 21 mm., which was about average for five specimens examined in the series. The primary wings are more rounded and square cut than in the male, where they are slightly narrower and more pointed at the apex. The allotype, as well as the other females in the series, is somewhat worn, but markings are similar to holotype. The color appears to be somewhat lighter, and the dark band across the wings is narrower and not so prominent as in the holotype, but this may be due largely to wear. The submarginal silvery line is much heavier and more irregular on the lower wing surface of the female than in the male. The color of the lower surface of the allotype is lighter and more yellowish brown than in the holotype.

The female allotype is labeled, Pernambuco, A. M. Moss, Rothchild Bequest, B.M. 1939-1 and is deposited in the British Museum. The allotype and females in the series are assumed to be females of *C. braziliensis* as indicated by the holotype, as they are found in the same area.

The male genitalia are distinctive as shown in the figures, but the female genitalia are somewhat similar and nearest to *C. inca* from Venezuela and Colombia.

There is a badly worn, small male specimen of a Calephelis with expanse of primary wings 17 mm. in the British Museum, labeled San Jose de Guatemala by Champion, in the Godman-

Salvin Coll. 1914-15, that looks like and has genitalia like *Calephelis braziliensis.* I have many other Calephelis specimens from practically the same locality in Guatemala, but none other that appears to be like *C. braziliensis.* It is to be noted that several of the *C. braziliensis* specimens, including the holotype are also in the Godwin-Salvin Collection, 1914-15 in the British Museum so it appears that this specimen was probably mislabeled as to locality according to evidence at hand.

The known range of *C. braziliensis* includes States of Pernambuco, Bahia, Ceara and Parabia in Brazil, South America. The holotype and allotype together with their genitalia slides will be deposited in the British Museum, as well as several paratypes, also paratypes will be deposited in the United States National Museum, American Museum and some others with consent of the owners.

No. 37 **Calephelis burgeri** McAlpine, new species

In the study of Calephelis material from the British Museum a female specimen was found which appears to be a new species. It has two labels on it, a small white label with black border, "End of rainy season," a larger white label with black border, "Purnio Co. E. X. — E. XI 96 (Dr. Burger)." These labels would indicate that the specimen was taken by Dr. Burger in October or November at end of rainy season, in 1896.

In correspondence Mr. Tite of the British Museum says: "I could not find the name Purnio on our maps but the name is mentioned by Dr. Burger in the book on his travels 'Reisen eines Naturforschers in Tropischen Sud America,' Leipsig 1900 on page 90. It is a small tributary of the Rio Magdalena, in the gold mining area of the Central Cordillera, Colombia. It joins the Magdalena between Conejo and Yeguas and is near a place called Victoria. A 280 meter plateau is mentioned near Purnio, and it may be where the insect was captured. Conejo is the only place mentioned that I can find on the map. It is on the R. Magdalena at about 5 degrees 30 minutes N. and I presume Purnio to be somewhere near it, probably to the south."

Female allotype primary wing expanse 24 mm. Upper surface lying within the inner metallic line is rather dull dark brown color, while balance of wing lying outside of inner metallic line is a trifle lighter reddish brown. The usual small black markings on basal half of upper wing surface are present but not well defined. The two marginal metallic lines are

silvery and quite distinct, the outer line being rather fine and straight, while the inner line is much heavier, irregular and more broken at the veins. It is not so inwardly exserted between M.1 and M.2 as in *C. laverna* that occurs in Colombia but is straighter, particularly noticeable on the lower surface. The usual row of black dots between the two silvery lines is present with the spots rather large. These spots are about midway between the two metallic lines and not closer to the outer metallic line as they are in *C. laverna.*

The fringes are brown and prominently checkered with white on both primaries and secondaries, while in *laverna* there is no such checkering.

The lower surface is dull rather dark yellowish brown, darker than in most Calephelis species, including *C. laverna,* and all markings of the upper surface are repeated and well defined. The wings are rounded and square cut as in *C. laverna* and in most females of Calephelis. The genitalia are quite distinctive as shown in the figure, and somewhat different from any other I have seen.

The holotype is such a well marked and attractive specimen with genitalia apparently different from other species, that I thought it best to name it, although it is just possible that it is a unique specimen of a known species.

The holotype with genitalia slide will be deposited in the British Museum.

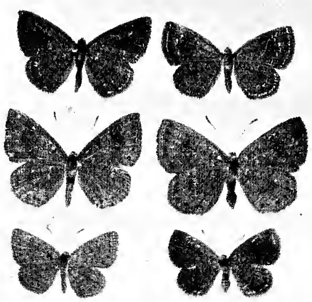


Fig. 6.—Upper set of six, upper side facies. Lower set of six, lower side facies. X ¾.

Top left, ♂ *Calephelis muticum* McAlpine. Paratype no. 5. Willis (swamp, Washtenaw County, Michigan), July 12, 1936.

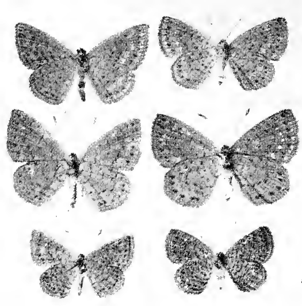
Top right, ♀ *Calephelis muticum* McAlpine. Bloomfield, Oakland County, Michigan. Aug. 1, 1915. W. S. McAlpine.

Center left, ♂ *Calephelis borealis* (Y. and R.). Sussex County, New Jersey, Otto Buchholz, July 10, 1938.

Center right, ♀ *Calephelis borealis* (Y. and R.). Sussex County, New Jersey, Otto Buchholz, July 4, 1938.

Lower left, ♂ *Calephelis virginiensis* G.-M. Fort Myers, Florida, Barnes collection, April 24, 1930.

Lower right, ♀ same.



CALEPHELIS PHOTOS

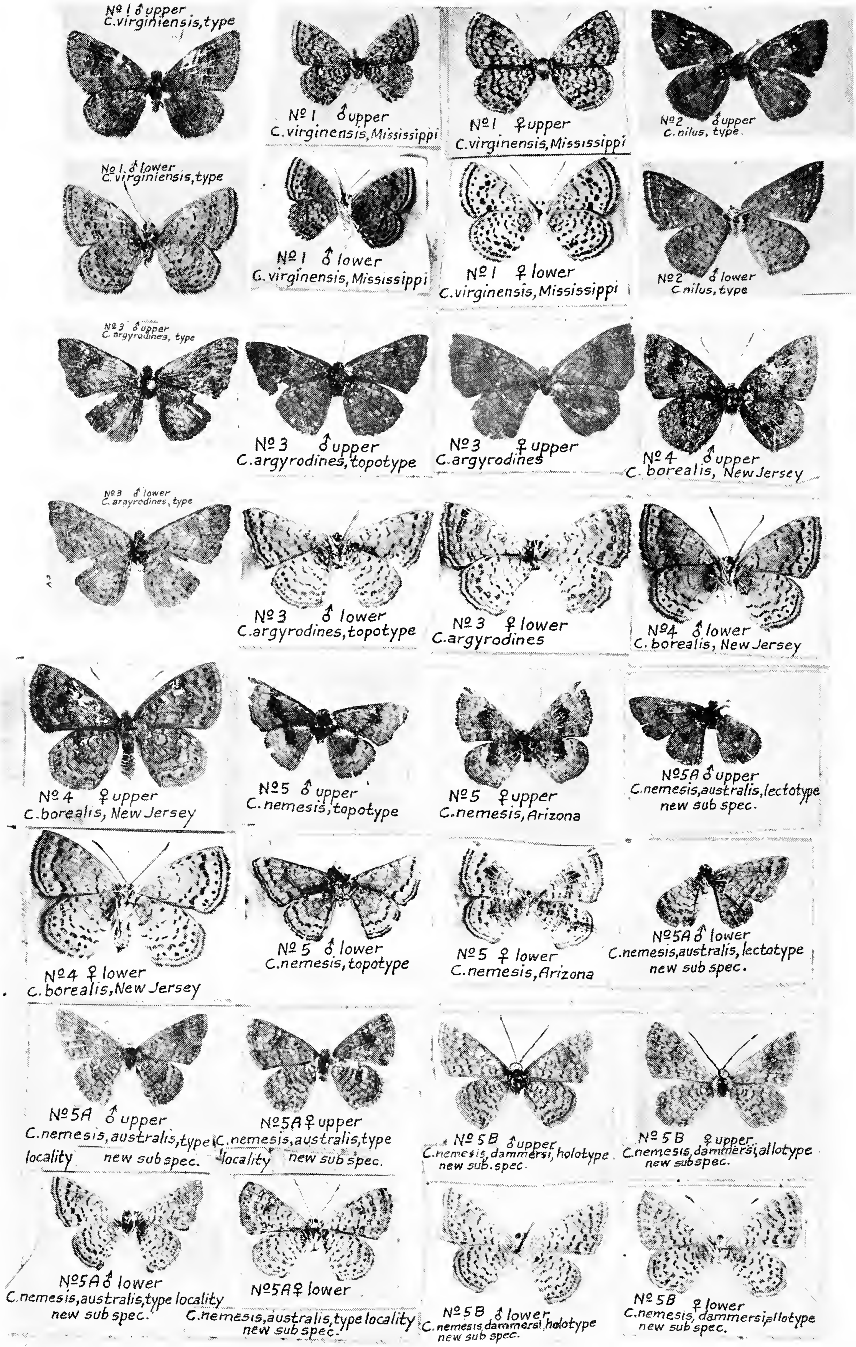


Figure 7

CALEPHELIS PHOTOS

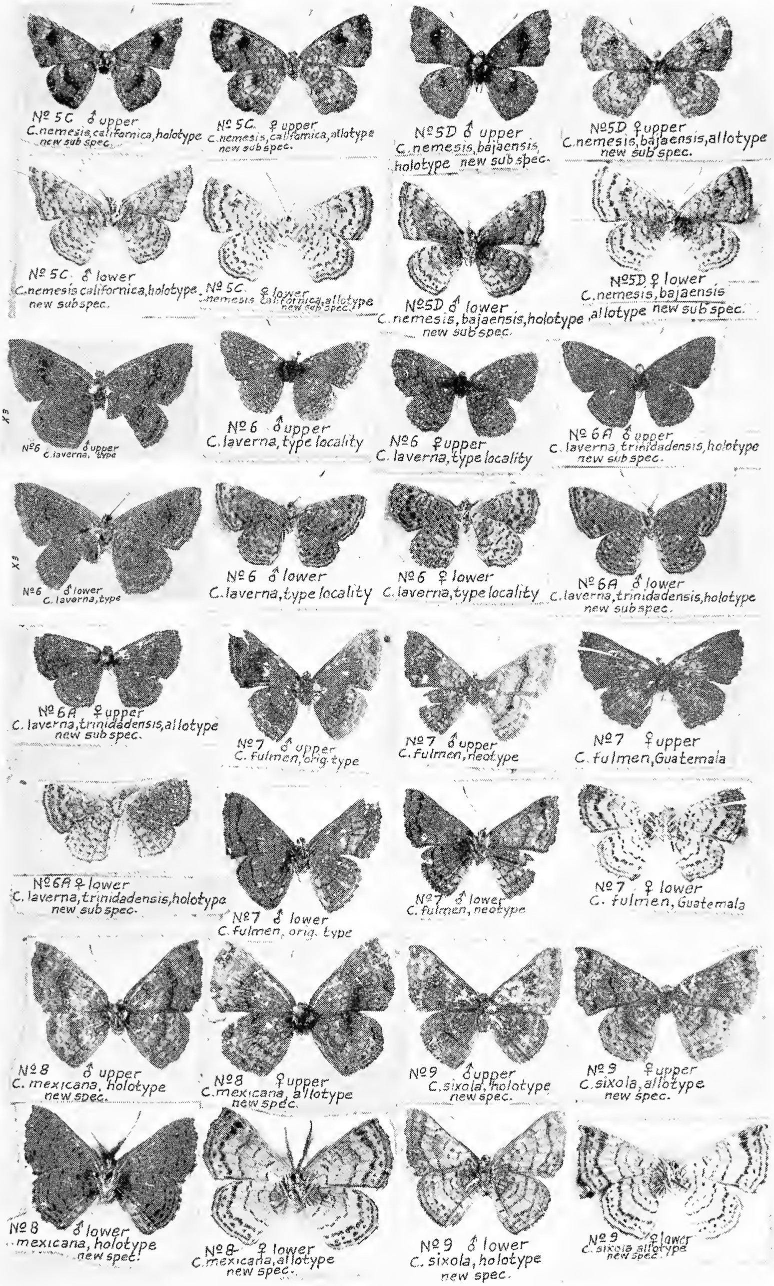


Figure 8

CALEPHELIS PHOTOS

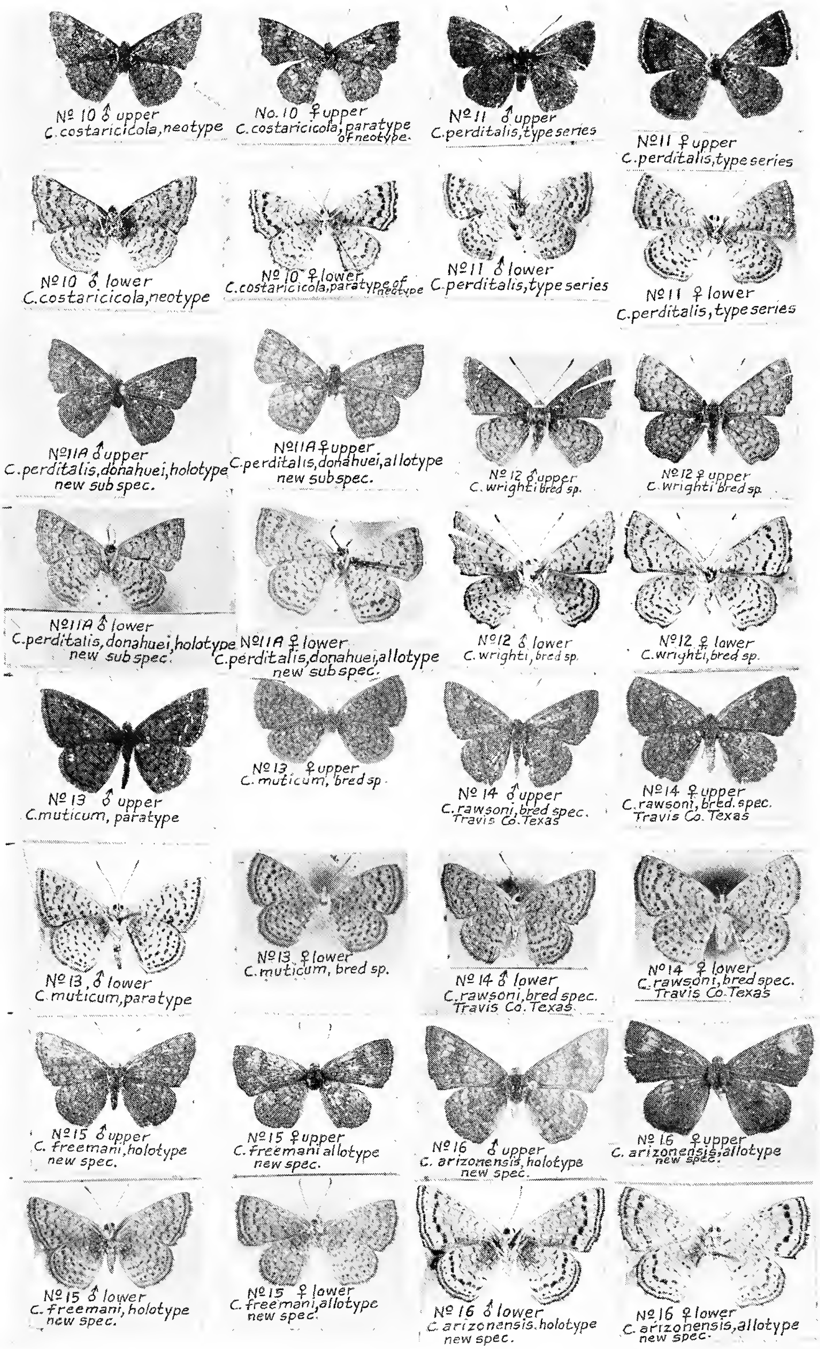


Figure 9

CALEPHELIS PHOTOS

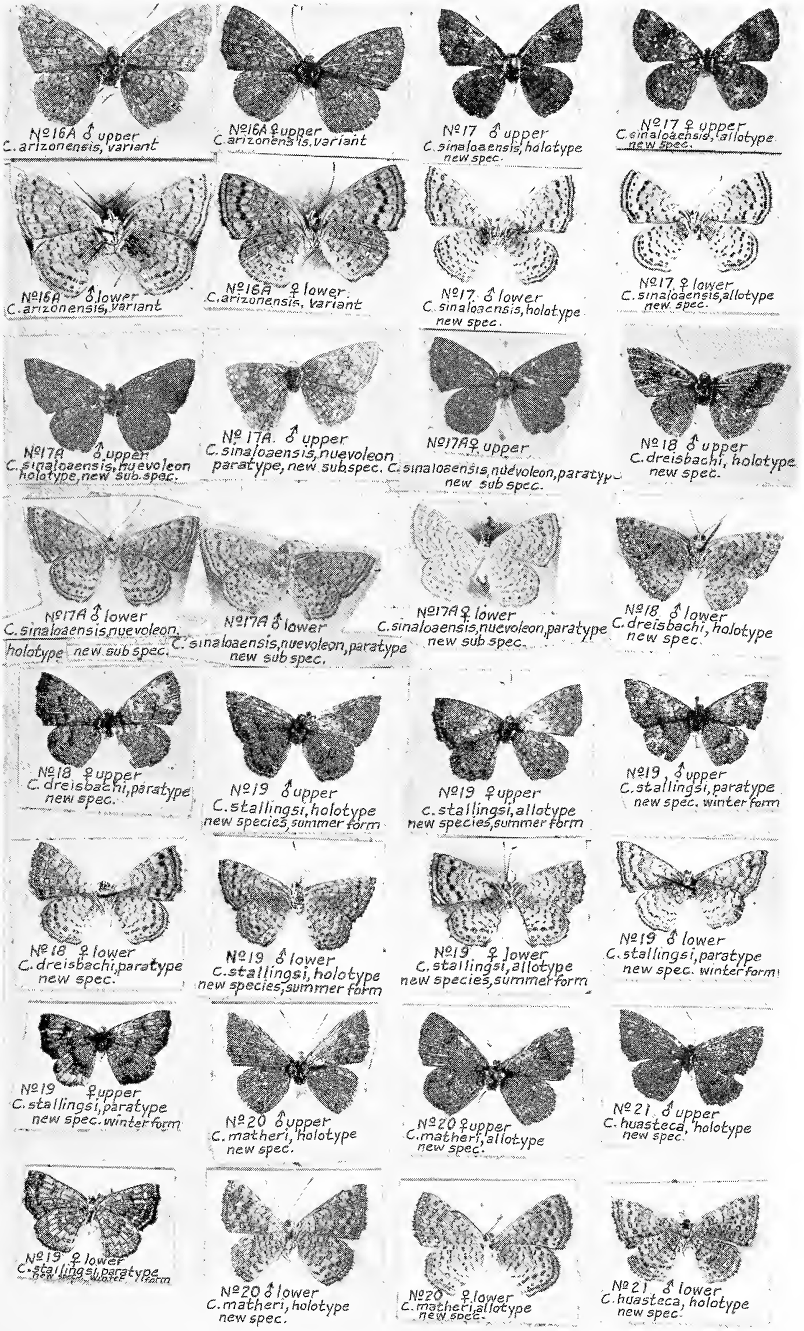


Figure 10

CALEPHELIS PHOTOS

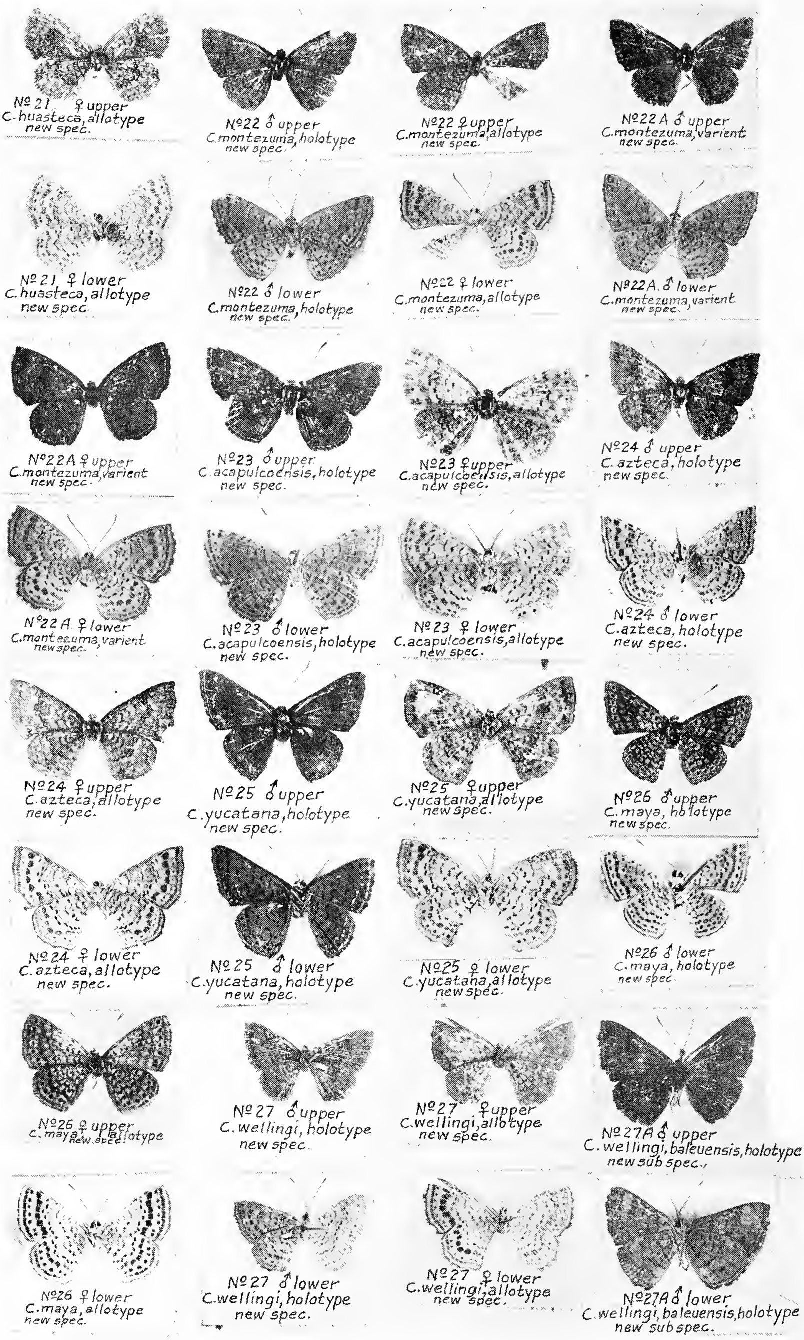


Figure 11

CALEPHELIS PHOTOS

Figure 12

CALEPHELIS PHOTOS

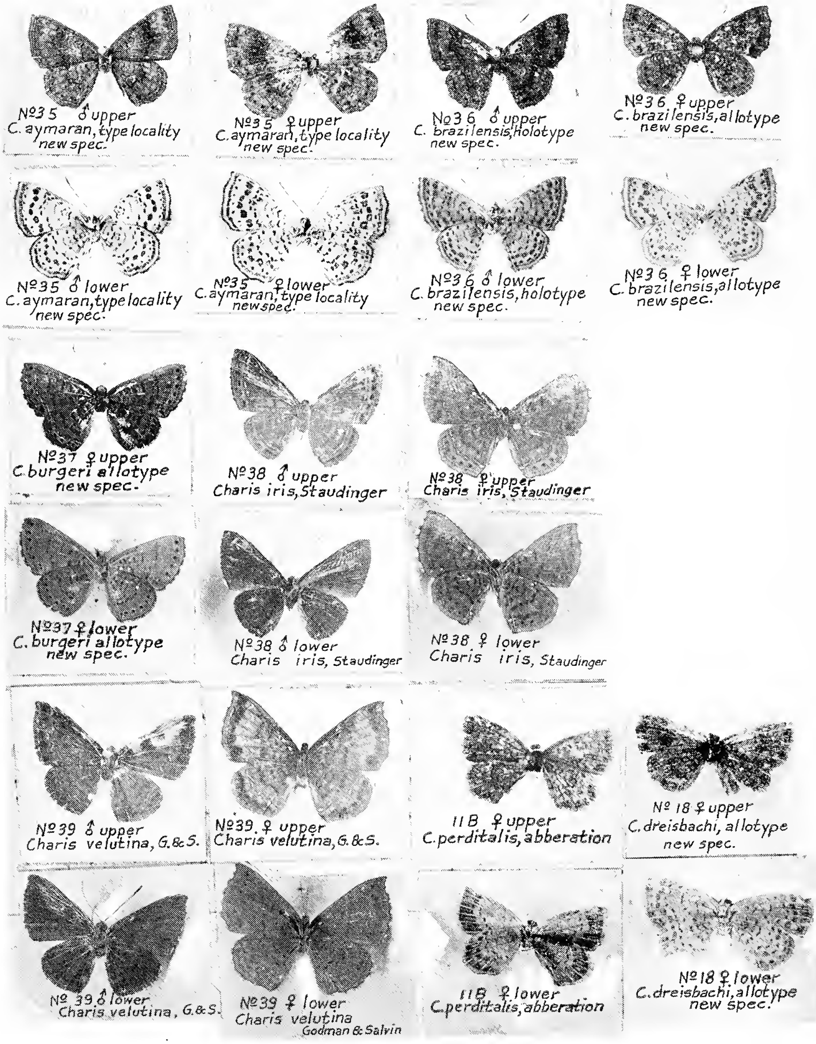


Figure 13

EXPLANATION OF SLIDES USED IN GENITALIA AND WING VENATION DRAWINGS

No. 1 *Calephelis virginiensis,*, Slide No. 606 Clinton Hines Co. Mississippi June 28, 1959 by Bryant Mather, Slide No. 1114, Baldwin Co., Alabama, May 22, 1927, Collection of Brooklyn Museum now in U.S.N.M. Slide No. 763 Clinton Hines Co. Mississippi, June 7, 1957. Collection of Bryant Mather. ♂ Slide No. 1389 (wing venation) Deschamps, Alabama.

No. 2 *C. nilus,* a doubtful species or species inquirenda, "Venezuela, Moritz type" label by Felder, slide No. 9605 in British Museum.

No. 3 *C. argyrodines,* Slide No. 256, Duenas, Guatemala by G. C. Champion. Collection of Godman-Salvin in B.M. Slide No. 776, Duenas, Guatemala by G. C. Champion, Godman-Salvin Coll. in B. M. ♂ Slide No. 204 (wing venation) San Pedrone, Yepocapa, Guatemala.

No. 4 *C. borealis,* Slide No. 2, Rockview, Pennsylvania by W. J. Gertsch, Slide No. 1113 Sussex C. New Jersey July 10, 1938 by Otto Buckholz, Slide No. 765, Sussex Co. New Jersey July 4, 1935 by Otto Buckholz. ♂ Slide No. 1394 (wing venation) Newton, New Jersey.

No. 5 *C. nemesis,*, Slide No. 141, Arizona in Coll. of W. H. Edwards in C. M. Slide No 140 Tucson, Arizona, by Geo. P. Englehardt. Slide No. 529 Proctors Ranch Madera Canyon Santa Rita Mts., Pima Co. Ariz., July 26, 1961 by Killian Roever. Slide No. 894 Madera Canyon Santa Rita Mts. Pima Co. Ariz. Slide No. 2780 Tuscon, Arizona, Picket Post Mt., by F. H. Graham. ♂ Slide No. 1612 (wing venation) Redington, Pima Co. Arizona.

No. 5A *C. nemesis australis,* Slide No. 71, type series, San Antonio, Texas, W. H. Edwards coll. in C. M., Slide No. 569, San Antonio, Texas Aug. 21, 1916 by W. W. Newcomb, Slide No. 2163 type series, San Antonio, Texas, W. H. Edwards coll. in C. M. ♂ Slide No. 569 (wing venation) San Antonio, Texas.

No. 5B *C. nemesis dammersi,* new sub. spec., Slide No. 722, Blythe, Riverside Co., Cal. July 21, 1931 by C. M. Dammers, Slide No. 2783, Blythe, Riverside Co., Cal. July 30, 1929 by C. M. Dammers, Slide No. 2784 Blythe, Riverside Co., Cal. July 3, 1935 by C. M. Dammers, Slide No. 1123 Blythe, Riverside Co., Calif. July 27, 1931 by C. M. Dammers. ♂ Slide No. 168 (wing venation) Blythe, California.

No. 5C *C. nemesis californica* new sub. spec., Slide No. 116, Riverside, Cal. Sept. 28, 1938 by C. M. Dammers, Slide No. 1119, Lakeside, San Diego Co., Cal. Sept. 26, 1941 by F. T. Thorne, Slide No. 2050, Gypsum Canyon, Orange Co., Cal. July 28, 1928 by C. M. Dammers, Slide No. 2169 Riverside, Calif. June 25, 1931 by C. M. Dammers. ♂ Slide No. 720 (wing venation) San Diego, California.

No. 5D *C. nemesis bajaensis,* new sub. spec., Slide No. 1548, A. San Bernardino, Sierra Lasuna. Baja Pen. Mexico, Nov. 18, 1961 C. M. Ace in C. M., slide No. 1547 Ro Palmarito, Baja Peninsula, Mexico, Nov. 30, 1961 Cary Carnegie Exp. in C. M. ♂ Slide No. 1527 (wing venation) San Jos del Cabo, Baja Penin., Mexico.

No. 6 *C. laverna,* Slide No. 535, Gatun, Canal Zone, Panama Aug. 14, 1945, Slide No. 1320, Canal Zone, Panama June 11, 1911, Yale Peruv. Exp. U.S.N.M. Slide No. 1135 El Queremal Carretera al mar val Colombia Aug. 1945 Richter Coll. A. M., Slide No. 1214, Gatun, Canal Zone, Panama Coll. of R. J. Jae.

No 6A *C. laverna, trinidadensis,* new sub. spec., Slide No. 2018, St.

Anns, Trinidad, British West Indies Apr. 11, 1933 by Albert Pinkus. A. M. Slide No. 811 Botanical Gardens, Port of Spain, Trinidad, Feb. 26, 1933 by Albert Pinkus, Amer. Mus. ♂ Slide No. 1398 (wing venation) Botanical Gardens, Port of Spain, Trinidad.

No. 7 *C. fulmen,,* Slide No. 667, Chiriqui Ribbe, Costa Rica, Berlin Museum, Slide No. 976 Cayuga Guatemala, Sept. Schaus and Barnes, in U.S.N.M. ♂ Slide No. 1373 (wing venation) Soloyapan, El Bajo, Mexico. ♀ Slide No. 1172 (wing venation) El Salto, Mexico.

No. 7A *C. fulmen* (variants), Slide No. 931 Xilitla, San Luis Potosi, Mexico by J. P. Donahue, Slide No. 935 Xilita, San Luis Potosi, Mexico by J. P. Donahue, Slide No. 1064, El Salto, San Luis Potosi, Mexico by H. A. Freeman.

No. 7B *C. fulmen* (variants), Slide No. 666, Tepescuintle, Municipio Tenosique, Tabasco, Mexico by E. C. Welling. Slide No. 623 Tepescuintle, Municipo Tenosique, Tabasco, Mex. Sept. 8, 1962, E. C. Welling. Slide No. 975 Tepescuintle Municipio Tenosique, Tabasco, Mexico by E. C. Welling.

No. 8 *C. mexicana,* new spec., in fulmen group, Slide No. 672, 17 mi. east of Concordia, Sinoloa, Mexico Nov. 1, 1961 by C. M. Ace, C. M. Slide No. 596, 19 mi. east of Concordia, Sinoloa, Mexico by C. M. Ace, C. M. Slide No. 1066 Tamazunchale, San Luis Potosi, Mexico Aug. 7, 1954 by H. A. Freeman, Slide No. 814 Xalapa, Jalapa, Vera Cruz, Mexico by W. Schaus, Slide No. 992, Fortin de los Flores Vera Cruz, Mexico, May 20, 1965 by Geo. W. Rawson, ♂ Slide No. 991 (wing venation) Fortin de los Flores Vera Cruz, Mexico, May 21, 1965 by G. W. Rawson.

No. 9 *C. sixola,* new spec., in fulmen group, Slide No. 973, Sixola River, Costa Rica, Sept. Schaus and Barnes Coll. in U.S.N.M., Slide No. 807 Banana River, Costa Rica, Mar. 1907 by Wm. Schaus U.S.N.M.

No. 10 *C. costaricicola,* Slide No. 1179 Mt. Redondo, Costa Rica, Mar. 2, 1902 Cary Coll. in C.M., Slide No. 822 Monte Redondo Costa Rica, Mar. 3, 1902, Cary Coll. C.M. Slide No. 823 Volcan, Frazu, Costa Rica, Apr. 22, 1902 Cary in C.M. ♂ Slide No. 1182 (wing venation) San Jose, Costa Rica.

No. 11 *C. perditalis,* Slide No. 124, San Benito, Texas, July 16, 1923 Barnes Coll. U.S.N.M., Slide No. 608, San Benito, Texas, Barnes Coll., Slide No. 781 San Benito, Texas, Barnes Coll., Slide No. 2166 San Benito, Texas, Barnes Coll. in U.S.N.M. ♂ Slide No. 153 (wing venation) Brownsville, Texas.

No. 11A *C. perditalis* (variants), Slide No. 127 Brownsville, Texas, May 18, 1938, Coll. of A. E. Brower, Slide No. 128 Loredo, Texas, June 13, 1935, H.A. Freeman, Slide No. 780 (aberrant) Cameron Co., Texas, Oct. 10, 1954, R. O. Kendall, Slide No. 1149 Brownsville, Texas, May 18, 1938, A. E. Brower, Slide No. 1153, Brownsville, Texas, June 23, 1938, A. E. Brower, Slide No. 1154, Corpus Christi, Texas, June 6, 1927, Frank Chermock, Slide No. 1232, Kennedy Co., Texas Bred Spec. by R. O. Kendall.

No. 11B *C. perditalis donahuei,* new sub-spec., Slide No. 928, 3 mi. S.W. of Jacala, Hidalgo, Mexico, El. 5800 ft. Aug. 1, 1963 by J. P. Donahue, Slide No. 927, 3 mi. S.W. of Jacala, Hidalgo, Mexico, El. 5800 ft. Aug. 1, 1963 by J. P. Donahue.

No. 12 *C. wrighti,* Slide No. 1112, Riverside, Cal. Aug. 22, 1938 by C. M. Dammers, Slide No. 1110, Riverside, Cal. July 11, 1933 by C. M. Dammers. ♂ Slide No. 1393 (wing venation) Grapevine Mt. Sissors Crossing, San Diego, Cal. by F. T. Thorne.

No. 13 C. muticum, Slide No. 1115, Willis, Wayne Co., Mich. July 17, 1932, by Sherman Moore, Slide No. 82 Mahopac, Oakland Co., Mich., July 17, 1932 by W. S. McAlpine, Slide No. 1109, Willis, Wayne Co., Mich., July 12, 1936 by W. S. McAlpine, Slide No. 766 Mahopac, Oakland Co., Mich., July 17, 1932, by W. S. McAlpine, ♂ Slide No. 1395 (wing venation), Oxford, Oakland Co., Mich. by W. S. McAlpine.

No. 14 C *rawsoni*, Slide No. 900, New Braunfels, Landa Park, Comal Co., Texas, Mar. 23, 1964 by W. S. McAlpine. Slide No. 899, New Braunfels, Landa Park, Comal Co., Texas, Mar. 24, 1964 by W. S. McAlpine, Slide No. 895 Landa Park, New Braunfels, Comal Co., Texas Mar. 23, 1964 by W. S. McAlpine, Slide No. 805 Landa Park, New Braunfels, Comal Co., Texas Mar. 29, 1961 by W. S. McAlpine. ♂ Slide No. 1611 (wing venation) New Braunfels, Texas, June 14, 1959 by W. S. McAlpine.

No. 15 *C. freemani*, Slide No. 876 Alpine, Texas June 9, 1942 by H. A. Freeman, Slide No. 861 Alpine, Texas, Davis Mts. June 5, 1942 by H. A. Freeman, Slide No. 346 Alpine, Texas, Davis Mts. June 5, 1942 by Stallings and Turner, Slide No. 859 Alpine, Texas, Davis Mts. June 5, 1942 by H. A. Freeman. ♂ Slide No. 330 (wing venation) Alpine, Brewster Co., Texas by H. A. Freeman.

No. 16 *C. arizonensis*, Slide No. 1661 Brown Canyon Baboquivari Mts. Pima Co., Arizona, by J. W. Tilden Mar. 17, 1938, Slide No. 1660 Brown Canyon, Baboquivari Mts. Pima Co., Arizona by J. W. Tilden on Mar. 20, 1938, Slide No. 2766 Brown Canyon, Baboquivari Mts., Pima Co., Arizona, Mar. 18, 1938 by J. W. Tilden. ♂ Slide No. 132 (wing venation) Brown Canyon, Baboquivari Mts., Pima Co., Ariz. J. W. Tilden.

No. 16A *C. arizonensis*, variants (probable seasonal forms), Slide No. 1662 Baboquivari Mts., Pima Co., Arizona by O. C. Poling Oct. 1-15, 1923, Slide No. 75, Baboquivari Mts., Pima Co., Arizona, Sept. 15-30, 1923 by O. C. Poling, Slide No. 2160 Baboquivari Mts., Pima Co., Arizona, Oct. 15-30, 1923 by O. C. Poling, Slide No. 2172 Baboquivari Mts., Pima Co., Arizona by O. C. Poling, Oct. 15-30, 1923. ♂ Slide No. 1399 (wing venation) Baboquivari Mts., Pima Co., Ariz., Poling. Oct. 1-15, 1923 U.S.N.M.

No. 17 *C. sinaloaensis*, new spec., Slide No. 905, 19 mi. East of Concordia, Sinaloa, Mexico, Oct. 25, 1951 C. M. Ace, C.M., Slide No. 673 five miles West of Concordia, Sinaloa, Mexico, Nov. 2, 1961 by C. M. Ace, C.M., Slide No. 919 Mazatlan, Sinaloa, Mexico, Oct. 28, 1961 by C. M. Ace, C.M. ♂ Slide No. 1400 (wing venation) 17 mi. East of Concordia, Sinaloa, Mexico.

No. 17A *C. sinaloaensis, nuevoleona*, new sub-spec., Slide No. 1042, Iturbide, Nuevo Leon, Mexico, Aug. 16, 1965 by W. S. McAlpine U.S.N.M. Slide No. 1140, State of Durango, Mexico, July 27, 1947 by W. Gertsch and M. Cazier for A.M.

No. 18 *C. dreisbachi*, new spec., Slide No. 1245 San Blas, Sinaloa, Mexico Sept. 13, 1957 by R. R. Dreisbach, Slide No. 1247 San Blas, Sinaloa, Mexico on Sept. 13, 1957 by R. R. Dreisbach, Slide No. 1244 San Blas, Sinaloa, Mexico, Sept. 13, 1957 by R. R. Dreisbach. ♂ Slide No. 1246 (wing venation) San Blas, Sinaloa, Mexico, Sept. 13, 1957 by R. R. Dreisbach.

No. 19 *C. stallingsi*, new spec., Slide No. 731 Valles, Mexico, June 8, 1941 by Stallings and Turner, Slide No. 792 two miles N.E. of Catemaco, Vera Cruz, Mexico on July 27, 1962 by G. N. Ross, Slide No. 1435 Tamazunchale, San Luis Potosi, Mexico, Sept. 23, 1966 by W. S. McAlpine, Slide No. 769 Tamazunchale, Mexico May 17, 1962 by Geo. W. Rawson. ♂ Slide No. 238 (wing venation) Valles, Mexico, ♀ Slide No. 1044 (wing venation) El Salto, Mexico.

No. 20 C. *matheri,* new spec., Slide No. 1633 San Jose, Purua, Michoacan, Mexico on Nov. 27, 1965 by Bryant Mather, Slide No. 1629 San Jose, Purua Michoacan, Mexico, Nov. 25, 1965 by Bryant Mather, Slide No. 1630 San Jose, Purua, Michoacan, Mexico, Nov. 25, 1965 by Bryant Mather. Slide No. 1628, San Jose, Purua Michoacan, Mexico, November 25, 1965 by Bryant Mather. ♂ Slide No. 1629 (wing venation) San Jose, Purua, Michoacan, Mexico.

No. 20A C. *matheri,* new spec., (variants), Slide No. 980 El Saus, Zacatecas, Mexico, El. 2100 M. Nov. 21, 1964 by E. C. Welling, Slide No. 979 El Saus, Zacatecas, Mexico, El. 2100 M. Nov. 21, 1964 by E. C. Welling, Slide No. 777 Baleas, Guerrero, Mexico, El. 1500 ft. by Wm. Schaus, U.S.N.M. Slide No. 1636 Ajijic, Jalisco, Mexico, Dec. 17, 1966 by R. G. Wind, C.M.

No. 21 C. *huasteca,* new spec., Slide No. 1450 Tamazunchale, San Luis Potosi, Mexico on June 19, 1964 by H. A. Freeman, Slide No. 1451 Tamazunchale, San Luis Potosi, Mexico, June 19, 1964 by H. A. Freeman, Slide No. 1046, Tamazunchale, San Luis Potosi, Mexico on July 18, 1963 by H. A. Freeman, Slide No. 773, Tamazunchale, Mexico June 6, 1941 by Stallings and Turner.

No. 22 C. *montezuma,* new spec., Slide No. 1444 Cuidad Valles, San Luis Potosi, Mexico Sept. 22, 1966 by W. S. McAlpine, Slide No. 506 Tamazunchale, San Luis Potosi, Mexico May 17, 1962 by Geo. W. Rawson, Slide No. 1410 Cd. de Valles, San Luis Potosi, Mexico Sept. 22, 1966 by W. S. McAlpine, Slide No. 846 Valles, Mexico, Dec. 30, 1941 by Stallings and Turner. ♂ Slide No. 1318 (wing venation) Misantla, Vera Cruz, Mexico.

No. 23 C. *acapulcoensis,* new spec., Slide No. 504, Acapulco, Guerrero, Mexico June 4, 1962 elev. 23 ft. by Geo. W. Rawson, Slide No. 505 Acapulco, Guerrero, Mexico June 12, 1962 by Geo. W. Rawson, Slide No. 960, Acapulco, Guerrero, Mexico Dec. 8, 1939 by F. H. Rindge, A.M. Slide No. 774 Acapulco, Guerrero, Mexico June 4, 1962 by Geo. W. Rawson, Slide No. 775 Acapulco, Guerrero, Mexico, June 4, 1962 Geo. W. Rawson. ♂ Slide No. 504 (wing venation) Acapulco, Guerrero, Mexico.

No. 24 C. *azteca,* new spec., Slide No. 319 Oriziba, Vera Cruz, Mexico on July 25, 1956 by R. R. Dreisbach, Slide No. 999 Fortin de los Flores, Vera Cruz, Mexico by Geo. W. Rawson, Slide No. 989 Fortin de los Flores, Vera Cruz, Mexico by Geo. W. Rawson, Slide No. 1004 Fortin de los Flores, Vera Cruz, Mexico April 28, 1965 by Geo. W. Rawson. ♂ Slide No. 998 (wing venation) Fortin de los Flores, Vera Cruz, Mexico.

No. 25 C. *yucatana,* new spec., Slide No. 619 X-Can Quintana Roo, Mexico, El. 200 m. July 19, 1962 by E. C. Welling, Slide No. 1331 X-Can Quintana Roo, Mexico, July 8, 1953 by E. C. Welling. ♂ Slide No. 1391 (wing venation) Sayolapan, El Bajo Oaxaca, Mexico.

No. 26 C. *maya,* new spec., Slide No. 657 Tepescuintle, Municipio Tenosique, Tabasco, Mexico, Oct. 21, 1962 El. 200 m. by E. C. Welling Slide No. 642 Chichen Itza, Yucatan, Mexico Dec. 8, 1962 by E. C. Welling, Slide No. 966 Chichen Itza, Yucatan Mexico, Slide No. 838 Chichen Itza, Yucatan, Mexico, Dec. 8, 1962 by E. C. Welling. ♂ Slide No. 640 (wing venation) X-Can Quintana Roo, Mexico.

No. 27 C. *wellingi,* new spec., Slide No. 951 Municipio Tenosique, Tabasco, Mexico El. 200 m. Sept. 12, 1962 by E. C. Welling, Slide No. 627 Tepescuintle Tabasco, Mexico, Oct. 1962 by E. C. Welling, Slide No. 841, Municipio Tenosique, Tabasco, Mexico, Oct. 18, 1962 by E. C. Welling. ♂ Slide No. 663 (wing venation) Tepescuintle Mu. Ten. Tabasco, Mexico.

No. 27A *C. wellingi, baleuensis,* new sub. spec., Slide No. 1980, Baleu, San Cristobal, verapaz Alta Verepaz, Guatemala, El. 4400 ft. Aug. 17, 1966 by E. C. Welling, Slide No. 1695, Baleu, Mpio San Cristobal, Verapaz, Alta Verapaz, Guatemala June 26, 1965 by E. C. Welling, Slide No. 1876 Baleu, Mpio, San Cristobal, Verapaz, Alta Verapaz, Guatemala, Aug. 13, 1966 by E. C. Welling.

No. 28 *C. sacapulas,* new spec., Slide No. 1193 Sacapulas, Guatemala Aug. 12, 1947 by P. Vaurie, A.M.

No. 29 *C. clenchi,* new spec., Slide No. 1816, Quisache, Mpio, Acatenango, Chimaltenango, Quatemala El. 1750 m. Aug. 1, 1965 by E. C. Welling, Slide No. 1830 Quisache, Mpio, Acatenango, Chimaltenango, Guatemala July 23, 1965 by E. C. Welling, Slide No. 1784 Quisache, Mpio, Acatenango, Chimaltenango, Guatemala, Aug. 5, 1965 by E. C. Welling, Slide No. 1798 Baleu, Mpio San Cristobal, Verapaz, Alta Verapaz, Guatemala Jan. 29, by E. C. Welling. ♂ Slide No. 1826 (wing venation) Quisache, Guatemala, Welling.

No. 30 *C. browni,* new spec., Slide No. 819 Turrialba Ais, Costa Rica, El. 620 m. May 30, 1945 by F. M. Brown for A.M., Slide No. 816 Turrialba, Ais, Costa Rica, May 29, 1946 by F. M. Brown, Slide No. 817 Hda. El Rodeo, Costa Rica, 900 m. June 11, 1946 by F. M. Brown for A.M. ♂ Slide No. 686 (wing venation) Turrialba Ais, Costa Rica.

No. 31 *C. schausi,* new spec., Slide No. 68 San Mateo, Costa Rica, Sept. Coll. W. Schaus U.S. National Museum, Slide No. 199 Tegucigalpa, Honduras, July 30, 1918, F. J. Dyer for Amer. Museum, Slide No. 1315 Avangariz, Costa Rica, July, Schaus and Barnes U.S. National Museum, Slide No. 818 Limon Farm, Rda El Rodeo, Costa Rica El. 700 m. Col by H. H. and F. M. Brown for American Museum, Slide No. 1178 San Mateo, Costa Rica, Oct. from Carnegie Museum. ♂ Slide No. 199 (wing venation) Tegucigalpa, Honduras.

No. 32 *C. guatemala,* new spec., Slide No. 154 Pacific Coast Guatemala F.D.G. and O.S. Valley of River Polochic, Hague, G. and S. Col. 1914-15 in B.M. Slide No. 259 S. Geronimo, Guatemala by Champion, Godman-Salvin Col. 1914-15 in B.M.

No. 32A *C. guatemala,* new spec., (variants), Slide No. 250 Guazacapan, Guatemala, Rothschild Bequest 1939-1 B.M. Slide No. 238 Polochic Valley, Guatemala, Godman and Salvin Col. 1914-15 B.M. Slide No. 239 Polochic Valley, Hague, Guatemala, G.D.G. and O.S. Co. B.M. Slide No. 156 Guazácapan, Gutemala, Rothschild Bequest 1939-1 in B.M.

No. 33 *C. inca,* new spec., Slide No. 1905, Cacagualito Dept. of Magdalena, Colombia, S.A. El. 1500 ft. May, Holland Col. C.M., Slide No .1904 Cacagualito, Dept. Magdalena, Colombia, S.A. El. 1500 ft. May Holland Col. C.M., Slide No. 1892 Cacagualito, Dept. Magdelena, Columbia, S.A. El. 1500 ft., May, Holland Col. C.M. ♂ Slide No 1893 (wing venation) Minca, Dept. Magdalena, Colombia, S.A.

No. 34 *C. tapuyo,* new spec., Slide No. 705 Orosi, Brazil, Aug. 1931 Col. of Albert Pinkus, in A.M., Slide No. 2002, Orosi, Brazil, Aug. 17, 1931, Col. of Albert Pinkus, in A.M.

No. 35 *C. aymaran,* new spec., Slide No. 1947 Rio Surutu, East Bolivia, S.A. El. 350 m. April 1915 Acc. 5570 C.M., Slide No. 1965 Rio Surutu, East Bolivia, S.A. El. 350 m. Holland Col. C.M., Slide No. 1951, Rio Surutu, East Bolivia, S.A. El. 350 m. J. Steinbach, Holland Col. C.M., Slide No. 131 Chanchamayo, Peru, Schuncke Col. Rothschild Bequest 1939, B.M., Slide No. 1948 Rio Surutu, East Bolivia, S.A. J. Steinbach, Holland Co. C.M. ♂ Slide No. 1994 (wing venation) Sapucay, Paraguay, S.A.

No. 35A *C. aymaran*, new spec., (variants), Slide No. 40, San Jacinthe Valley, Theophilo Ottoni, Minas Geraes, Brazil by F. Birch 1907-8 Rothschild Bequest, B.M. 1939-1, Slide No. 55 Tejuco, Brazil, Dec. Rothschild Bequest, B.M. 1939-1., Slide No. 20 Itaparica, Brazil, Dec. 16, 1905 Meade-Waldo 1906-162 B.M., Slide No. 131 Chanamayo, Peru, Schuncke Col. Rothschild Bequest, B.M. 1939-1.

No. 36 *C. brazilensis*, new spec., Slide No. 1990, Pernambuco, North Brazil, S.A. by W.A. Forbes in B.M., Slide No. 1991 Cabo, Pernambuco, Brazil, S.A., A. M. Moss, Rothschild Bequest, B.M., Slide No. 90 Rothschild Bequest 1939-1 B.M., Slide No. 13 Bahia, Brazil, Rothschild Bequest 1939-1 B.M., ♂ Slide No. 681 (wing venation) Tiuma, Pernambuco, Brazil, S.A.

No. 37 *C. burgeri*, new spec., Slide No. 198 Purnio, Colombia El. 280 m. EX-E XI. 96 Dr. Burger,, in B.M. End of Rainy Season.

No. 38 *Charis iris*, Slide No. 1380 Juan Vinas 2500 to 3500 ft. Costa Rica, Oct. 1906, U.S.N.M., Slide No. 1379 Peralta, Costa Rica, Feb. 1907, Wm. Schaus, U.S.N.M. ♂ Slide No. 1380 (wing venation) Juan Vinas, Costa Rica, El. 2500 ft., Oct. 1905, U.S. Nat. Mus.

No. 39 *Charis velutina*, Slide No. 2062 Chejel, Guatemala, Edwin T. Owen Coll., U.S.N.M., Slide No. 1381 Oriziba, Mexico, Jan. 1909, R. Muller, U.S.N.M. ♂ Slide No. 2062 (wing venation) Chejel, Guatemala (Edwin Owen Coll.), U.S. Nat. Mus.

CALEPHELIS WING VENATION

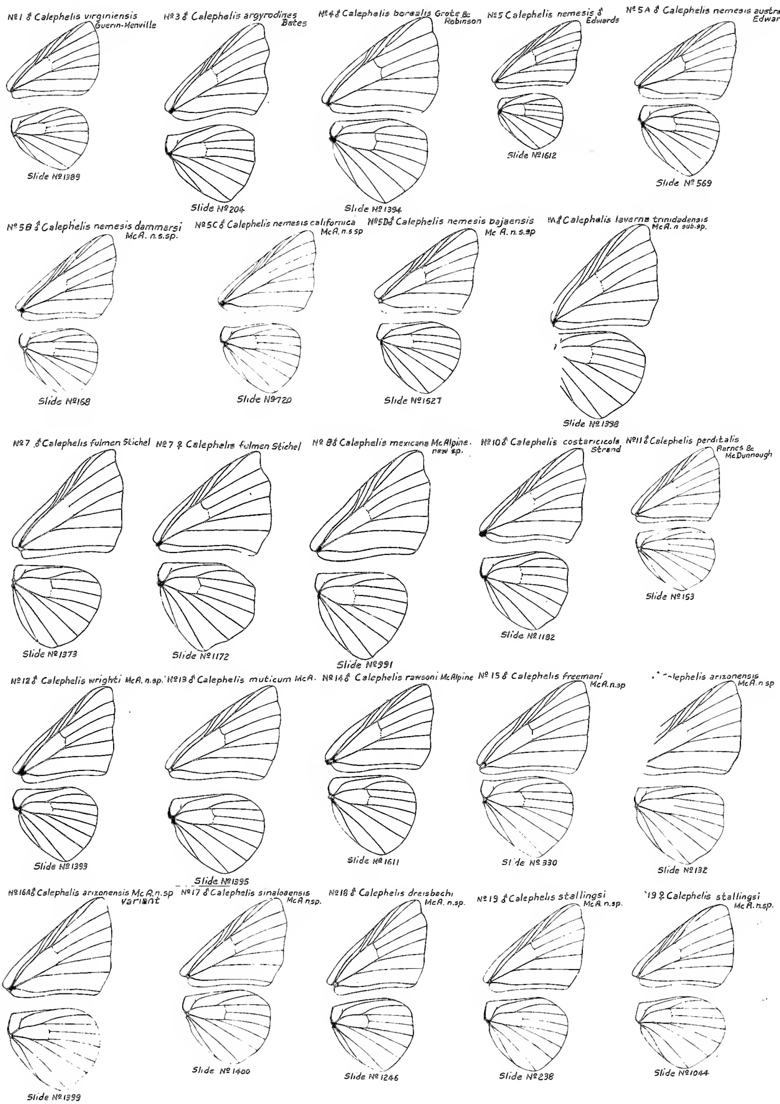


Figure 14

CALEPHELIS WING VENATION

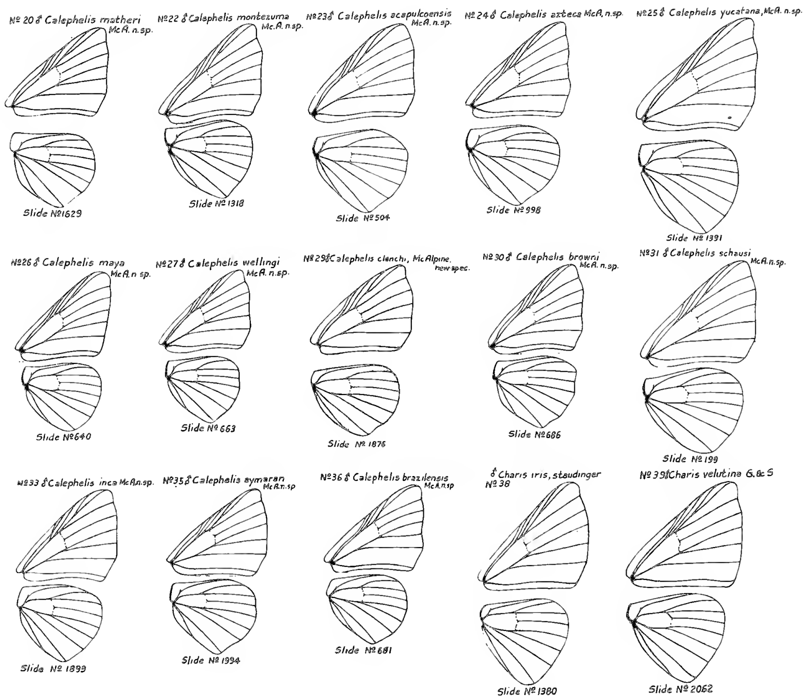


Figure 15

CALEPHELIS GENITALIA

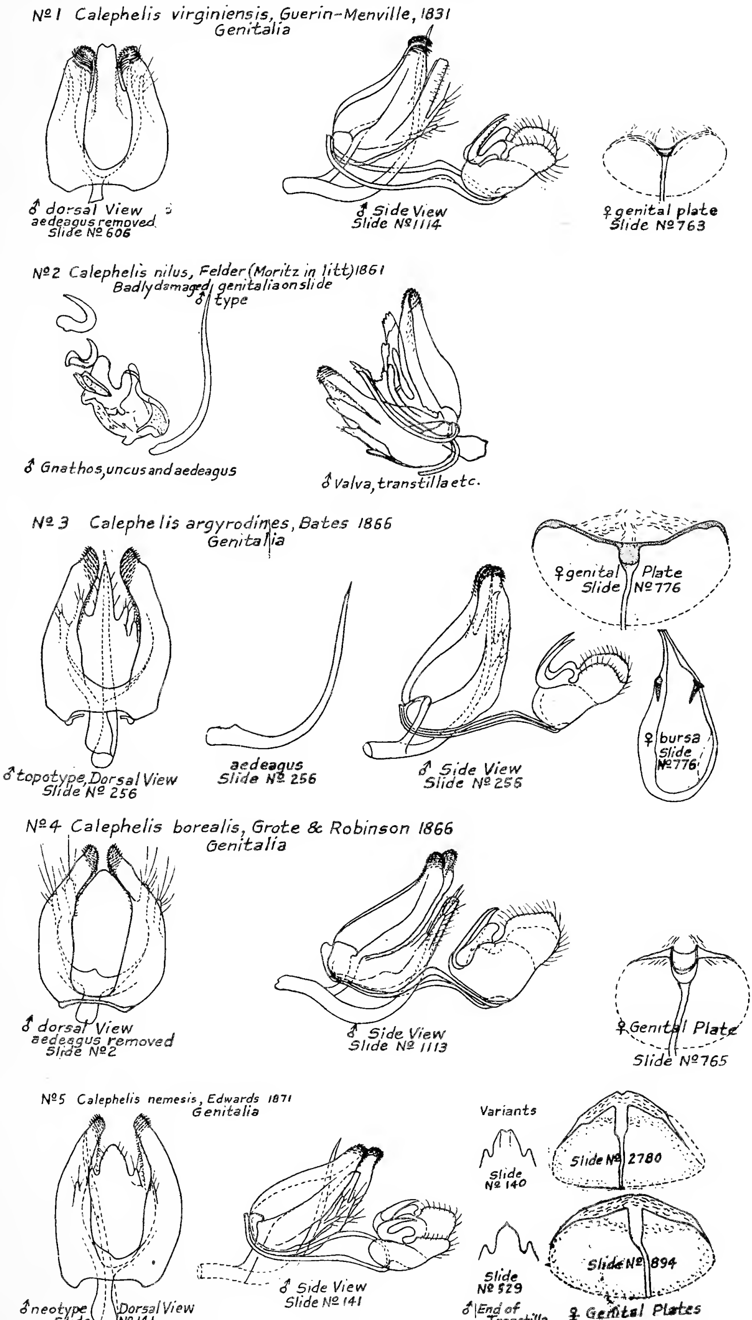


Figure 16

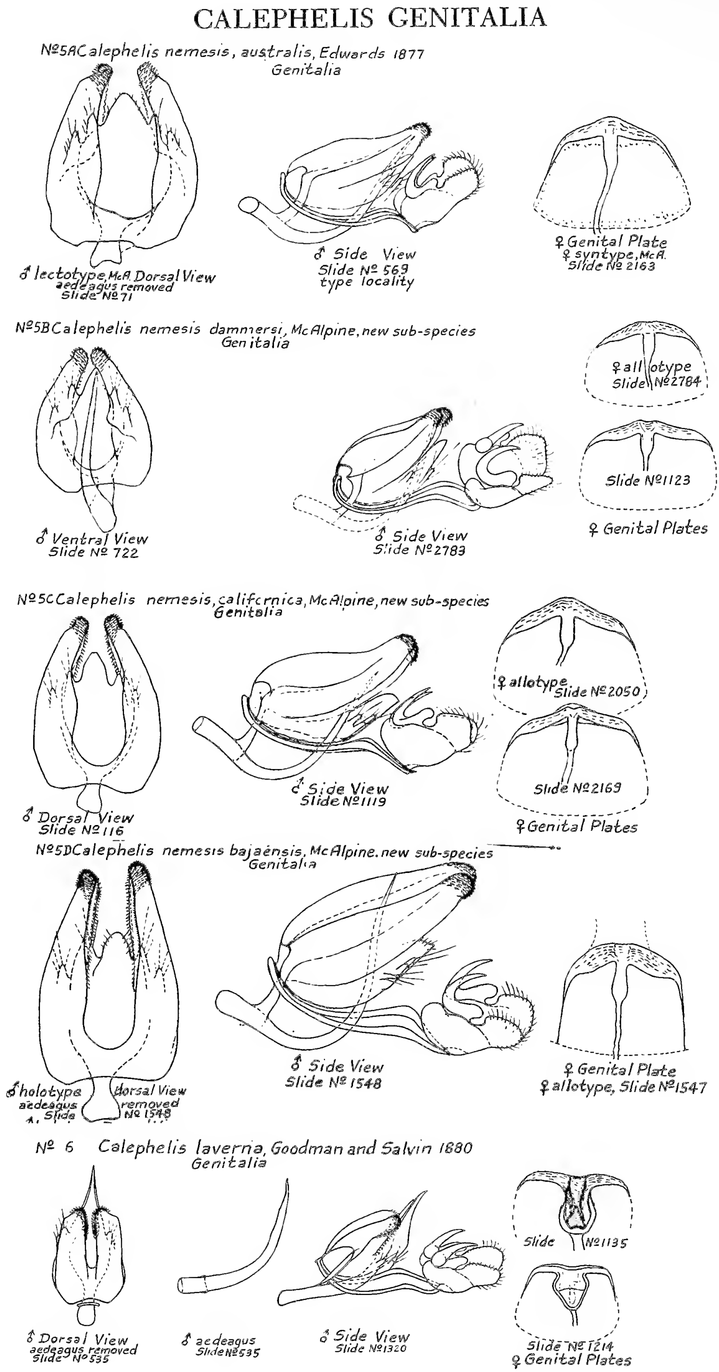

CALEPHELIS GENITALIA
Nº5A Calephelis nemesis, australis, Edwards 1877
Genitalia
♂ lectotype, McA. Dorsal View
aedeagus removed
Slide Nº 71
♂ Side View
Slide Nº 569
type locality
♀ Genital Plate
♀ syntype, McA.
Slide Nº 2163
Nº5B Calephelis nemesis dammersi, McAlpine, new sub-species
Genitalia
♀ allotype
Slide Nº 2784
Slide Nº 1123
♀ Genital Plates
♂ Ventral View
Slide Nº 722
♂ Side View
Slide Nº 2783
Nº5C Calephelis nemesis, californica, McAlpine, new sub-species
Genitalia
♀ allotype Slide Nº 2050
Slide Nº 2169
♀ Genital Plates
♂ Side View
Slide Nº 1119
♂ Dorsal View
Slide Nº 116
Nº5D Calephelis nemesis bajaensis, McAlpine. new sub-species
Genitalia
♂ Side View
Slide Nº 1548
♀ Genital Plate
♀ allotype, Slide Nº 1547
♂ holotype Dorsal View
aedeagus removed
Slide Nº 1548
Nº 6 Calephelis laverna, Goodman and Salvin 1880
Genitalia
Slide Nº 1135
Slide Nº 1214
♀ Genital Plates
♂ Dorsal View
aedeagus removed
Slide Nº 535
♂ aedeagus
Slide Nº 535
♂ Side View
Slide Nº 1320

Figure 17

CALEPHELIS GENITALIA

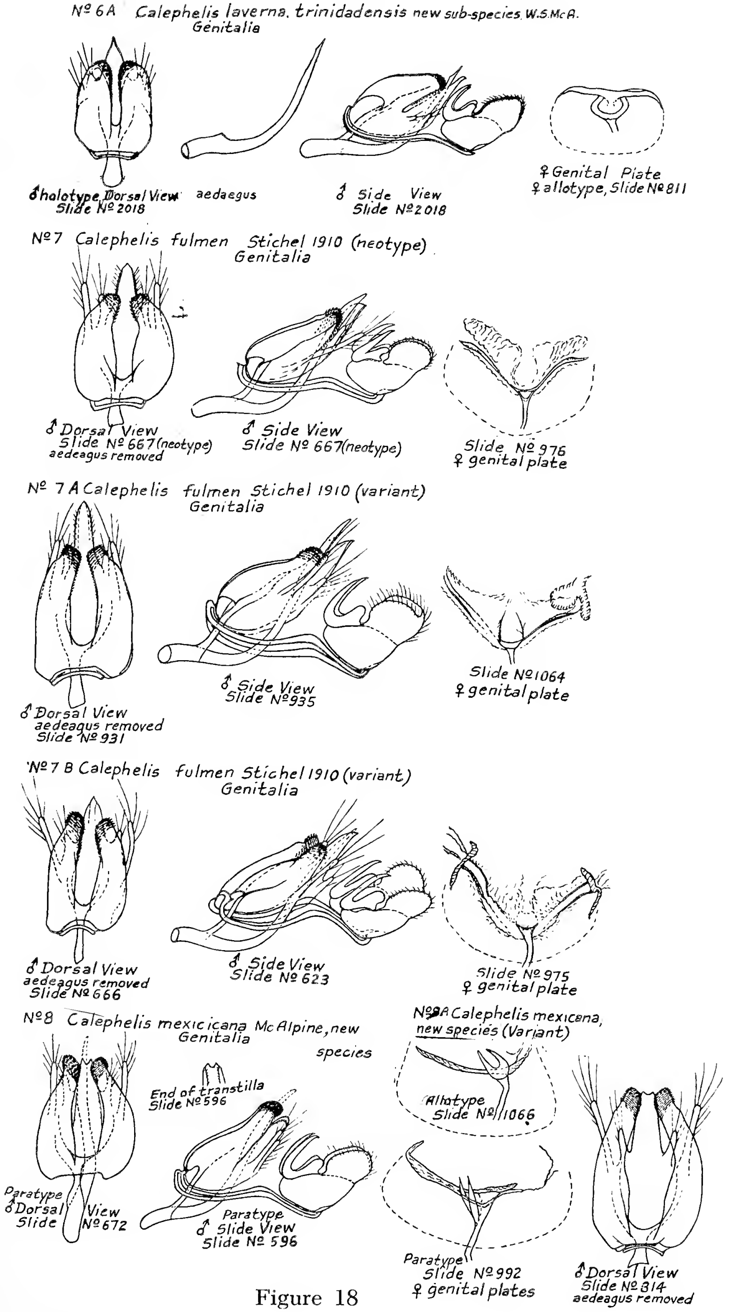


Figure 18

CALEPHELIS GENITALIA

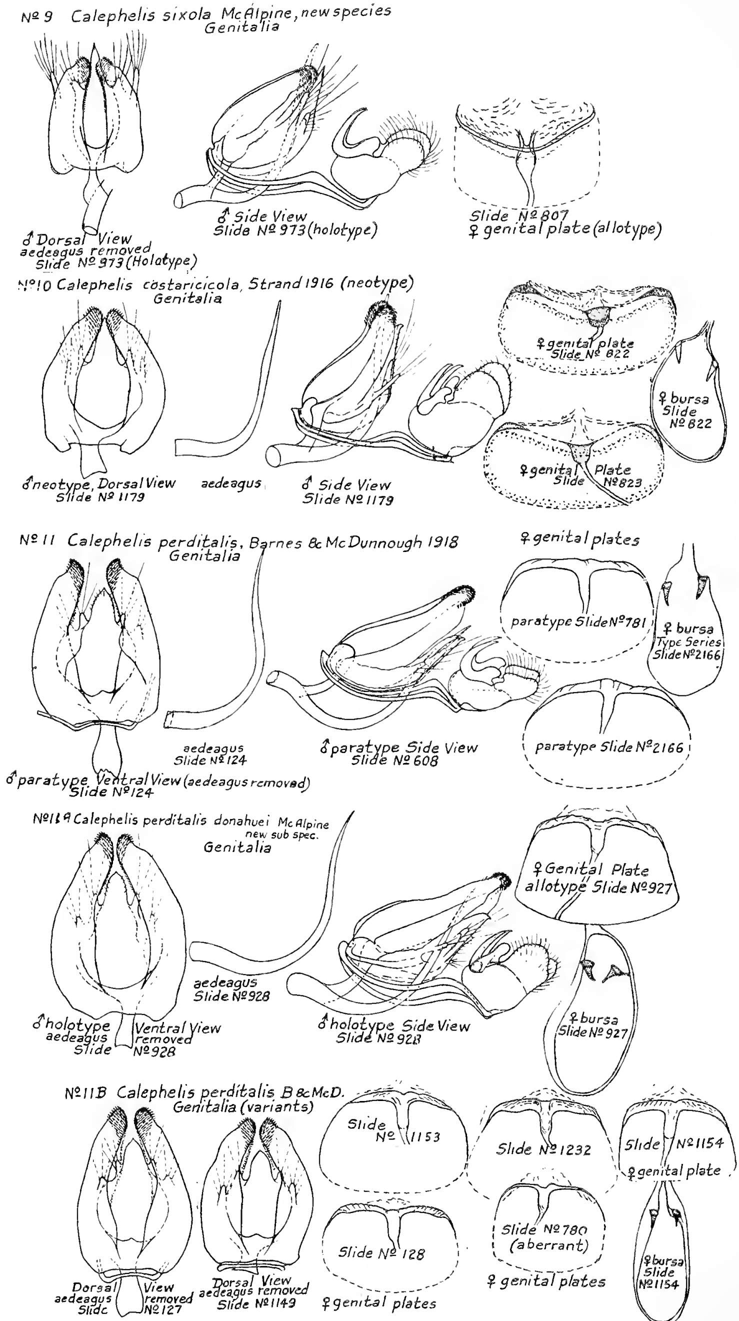


Figure 19

CALEPHELIS GENITALIA

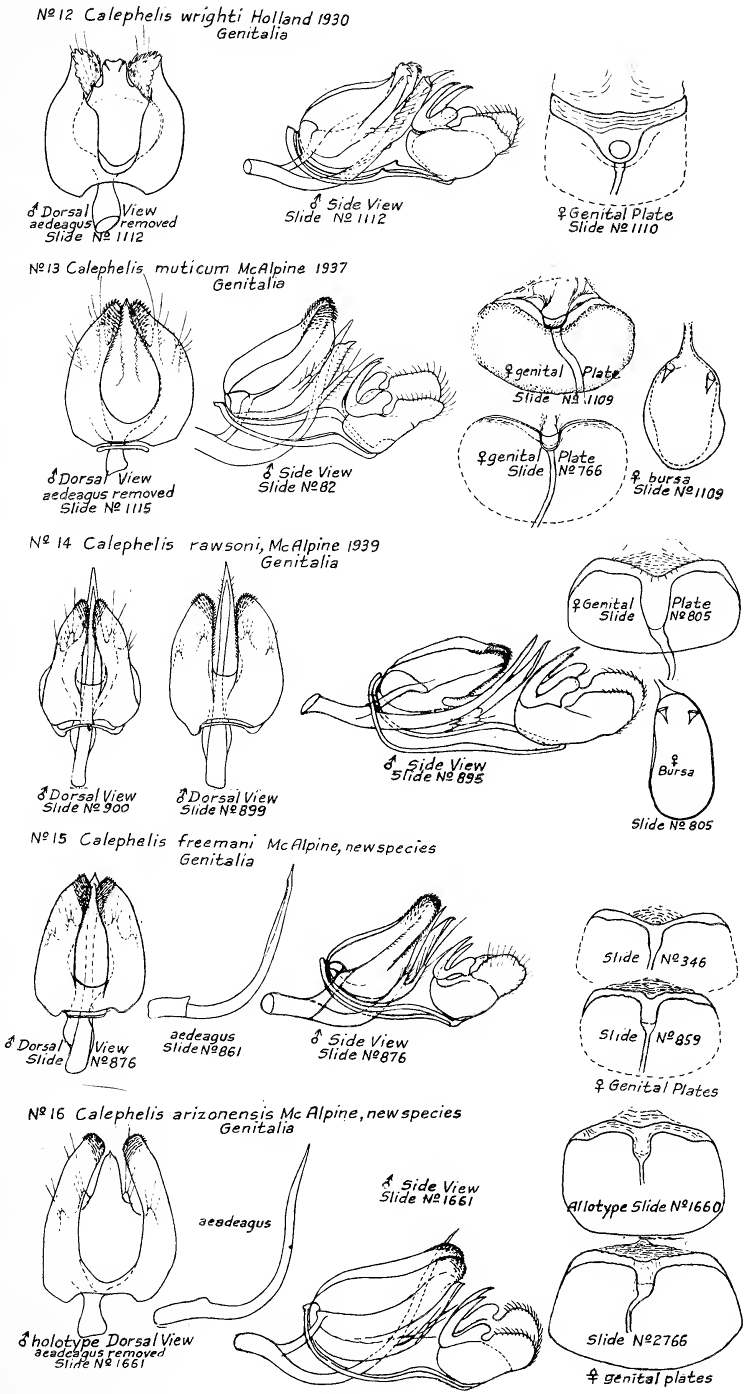


Figure 20

CALEPHELIS GENITALIA

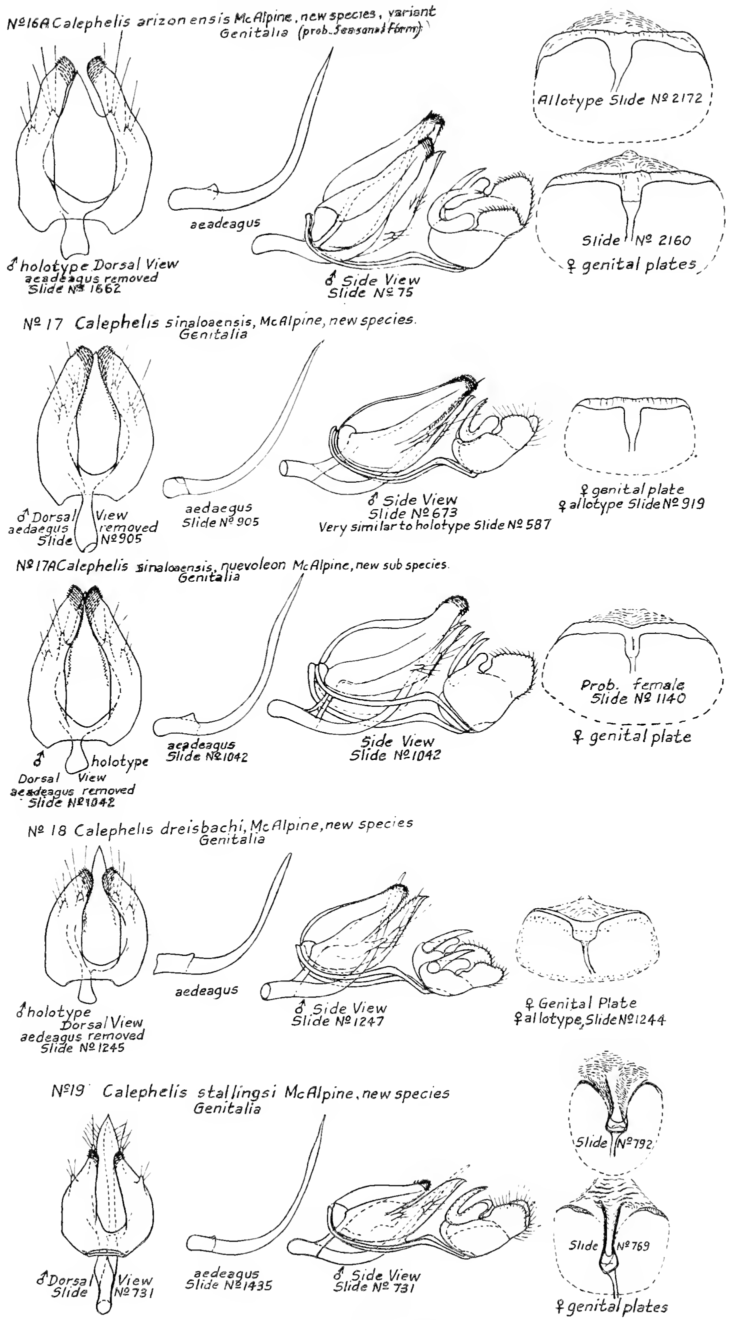


Figure 21

CALEPHELIS GENITALIA

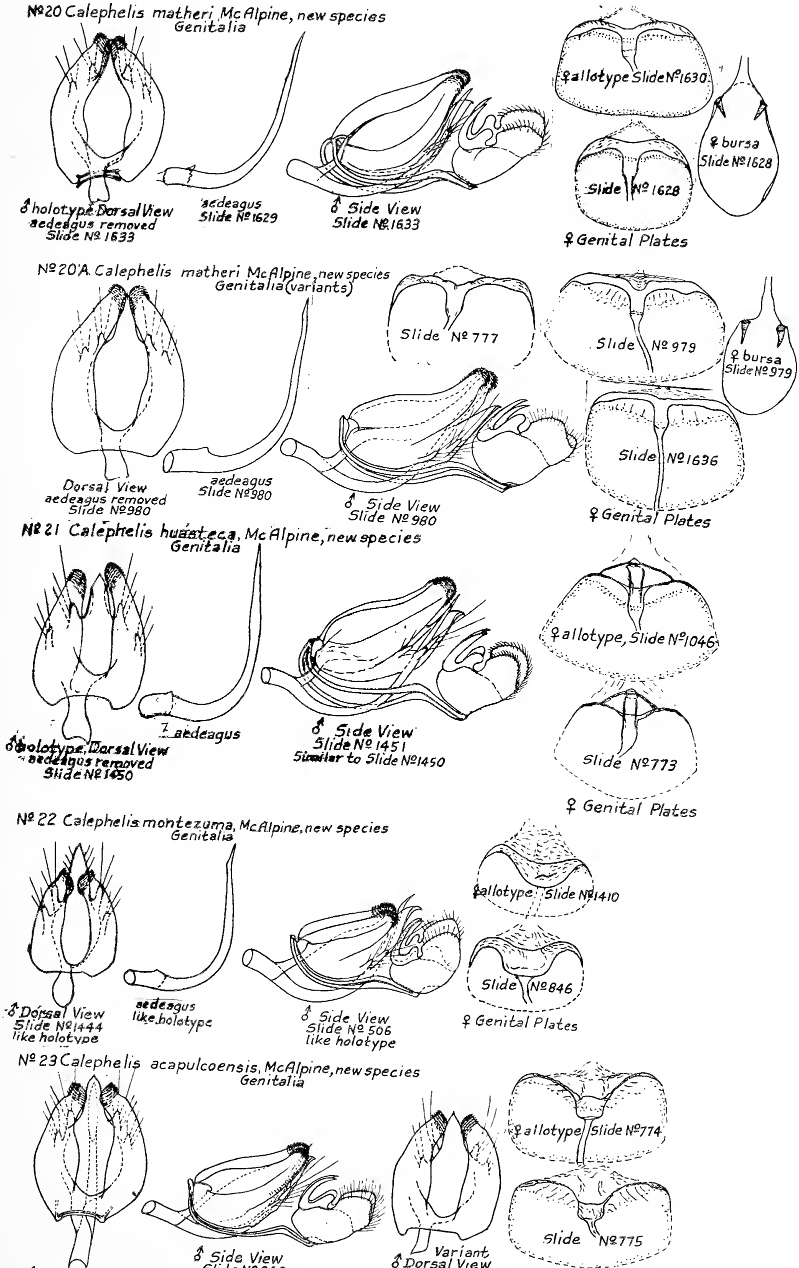


Figure 22

CALEPHELIS GENITALIA

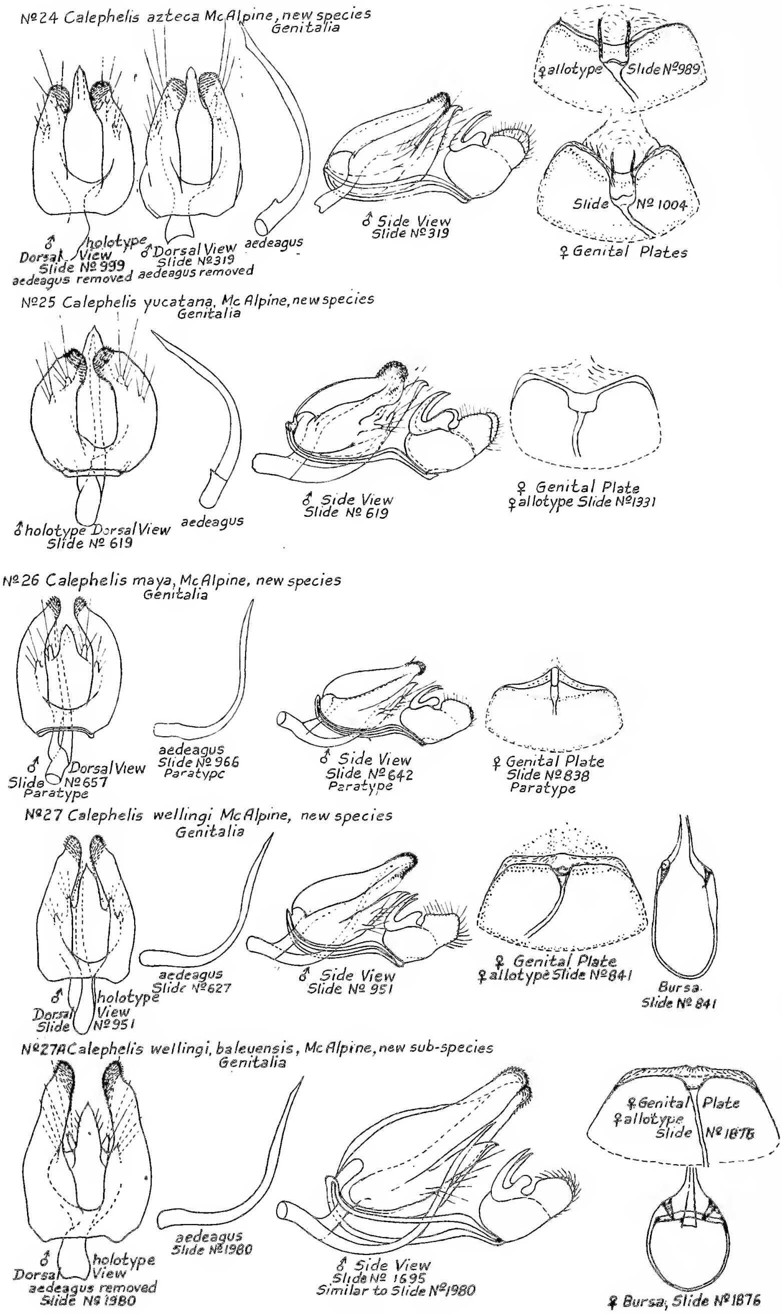


Figure 23

CALEPHELIS GENITALIA

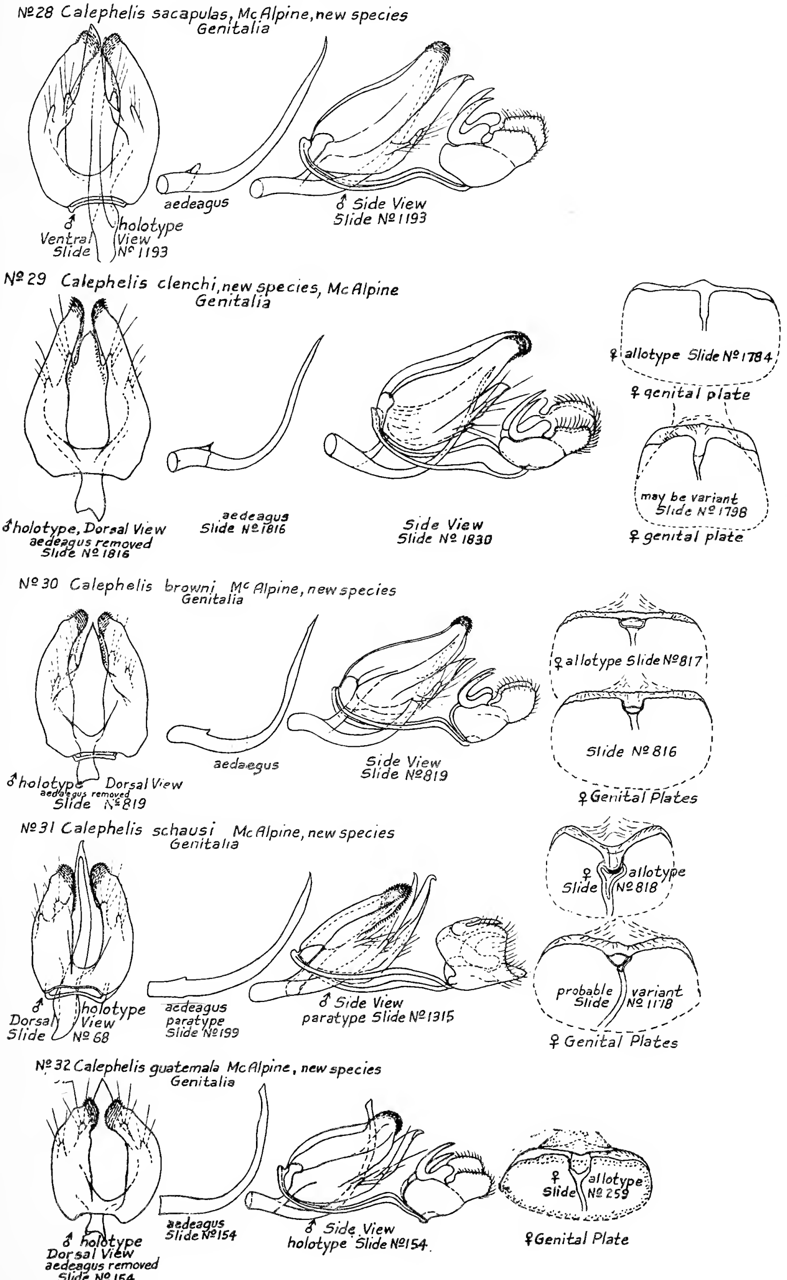


Figure 24

CALEPHELIS GENITALIA

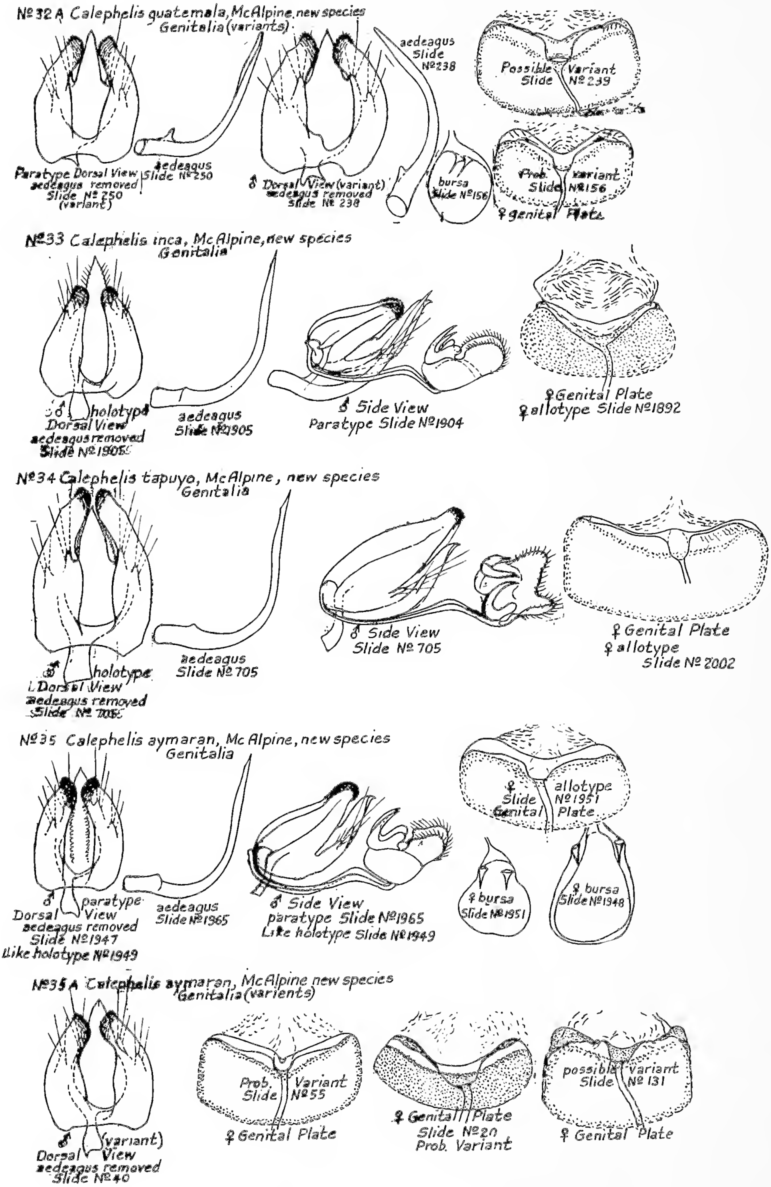


Figure 25

CALEPHELIS GENITALIA

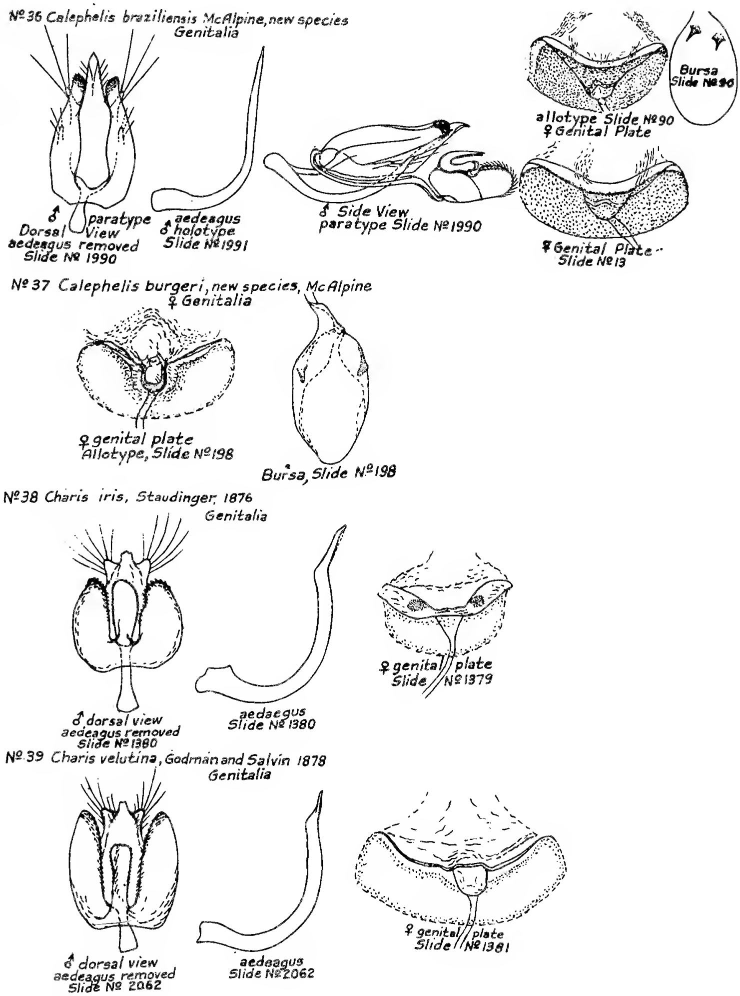
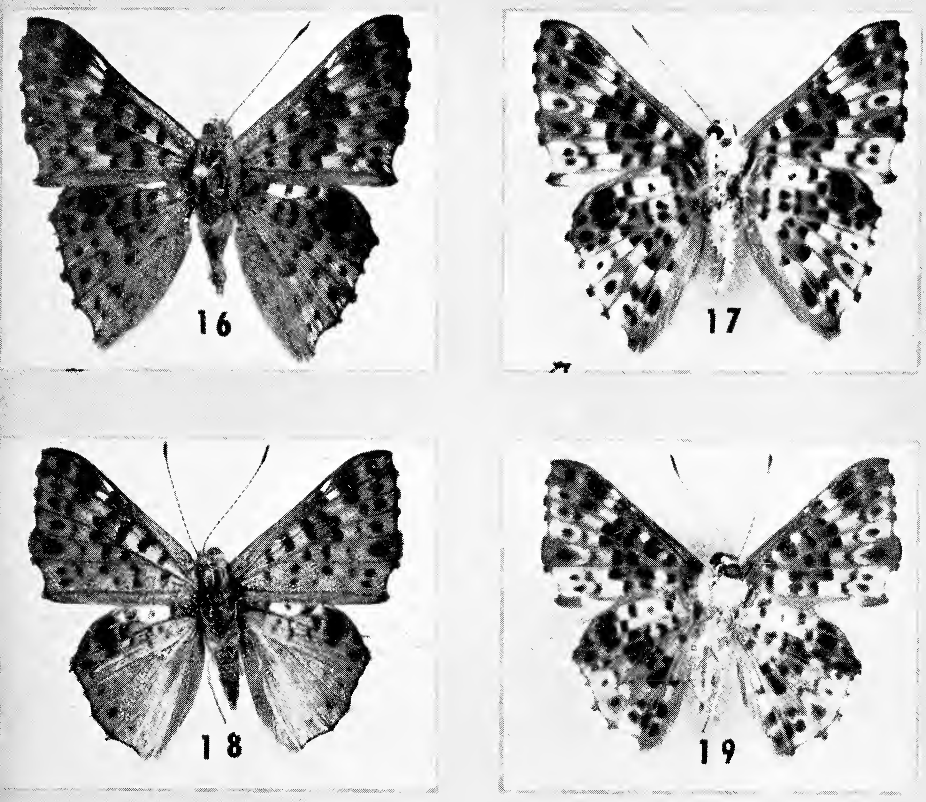


Figure 26

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 10 *Number 1* *March, 1971*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA



Volume 10 Number 2 June, 1971 (1972)

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 10(2):127-147, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

PUPAL SOUND PRODUCTION OF SOME LYCAENIDAE

OVE HOEGH-GULDBERG
Naturhistorisk Museum, 8000 Aarhus, Denmark

STRUCTURE AND SOUND

Introduction

SOUNDS PRODUCED BY PUPAE have been known for nearly 200 years (Kleeman's listening to *Callophrys rubi* L., 1774). Prell (1913) described the noise and made drawings of the stridulatory devices in *Thecla quercus* L. Hinton (1948) summarized the general literature on pupal sound in the Lepidoptera and presented four types of mechanisms involved. Downey (1966) brought together the scattered information on sound in pupae of Lycaenidae and noted the occurrence of the organs which produce sound in a great number of species, and he was able to increase the list of known sound producing Lycaenid pupae from 25 previously reported to 82.

The external structures involved in sound production in Lycaenidae can be located to membrane 4 (i.e. the membrane infolded between segments 4 and 5), but is always found, if present, on membrane 5, and generally limited to the dorsal region. An anterior stridulating plate is found, often heavily sclerotized and variously sculptured; then follows a thin transparent membrane devoid of common structural features; posteriorly a file, opposed to the plate, completes the device.

Prell (1913), Strawn (1964) and Downey (1966) have described longitudinal muscles in various Lycaenids, connecting parts on either side of the stridulating apparatus, both in pupae and in the pharate adult inside the pupa; in the latter the muscle continues in a short ligament from the integument to the fifth intersegmental membrane of the pupa; Strawn calls these "stridulating attachments." The presence of this muscle (and later muscle + ligament) explains, how the pupa through-

out is able to produce sounds from early pupal stage until emergence. It was not possible to locate scars or rudiments of the ligament on imagines. Antagonistically working muscles were not found, and it is therefore assumed that the fluid pressure may return the movement to a resting position.

In *Lycaena thoe* Guer. Downey (1966) detected a pupal sound within minutes after the larval skin was shed, and an individual was also heard to stridulate up to the emergence.

There is some question as to which stage of the life cycle is involved in this phenomenon. The name "pharate" has been proposed by Hinton (1946) to designate the phase of an instar which is enclosed within the cuticle of the previous instar, and Downey holds that stridulating response in Lycaenidae may be limited to pharate adult behaviour, which accordingly implies that the real pupal stage would have to be considered as occurring during that brief quiescent period ordinarily thought of as "pre-pupal" interval, and most "pupal" movements as belonging to the pharate adult.

Downey (1966) working with *Lycaena thoe* Guer., was able to associate the sound with "extremely rapid movements" of abdominal segments posterior to segment five, and here he disclosed the microscopic stridulatory organs. Dickson (1952) stated that when a pupa of *Phasis zeuco zeuco* L. was touched, the portion of the abdomen beyond the fourth segment was seen to move with a "rapid, almost trembling motion."

PRESENT INVESTIGATIONS

In view of this work and the many theories raised to explain the function of the sounds produced, it is remarkable that so little experimental research on live pupae has actually been done.

The following pages describe a number of varied experiments which have been carried out with pupae of *Aricia artaxerxes* F. (*allous* G.-Hb.)—50 specimens of ssp. *vandalica* Kaaber and Hoegh-Guldberg, and 11 ssp. *salmacis* Stph., 10 *A. agestis* Schiff., 10 *Polyommatus icarus* Rott., 5 *Plebeius argus* L., 2 *Thecla quercus* L., and 18 *Celastrina argiolus* L.

Structures and sounds investigated in *Aricia artaxerxes* and *A. agestis*

Anatomy

The two *Ariciae* species which were the main subject of the experiments were eminently suited for the purpose, as pupal development at ordinary room temperature is regular and of only about 15 days duration. After two to four days in the prepupal stage, the larva casts its skin and the fresh pupa is pale green and soft, and for the first day or two so thin-walled that if it is injured, nearly all the contents will run out in clear drops. It cannot produce sounds until it is 3-4 days old and hardened. (If the newly-formed pupa of *Lycaena thoe* Guer. should in fact be able to produce sounds, the stridulating mechanism must be chitinized even in the larval stage).

There was not found any difference, neither in anatomy nor concerning the sounds, between *A. agestis* and *A. artaxerxes*.

Aricia pupae can produce sounds from the fourth pupal day and from then regularly until emergence ten days later.

In the rigid pupae of the 6 Lycaenids investigated, only this cleft between 5th and 6th abdominal segments on the dorsal side allows of any larger movement (Fig. 1).

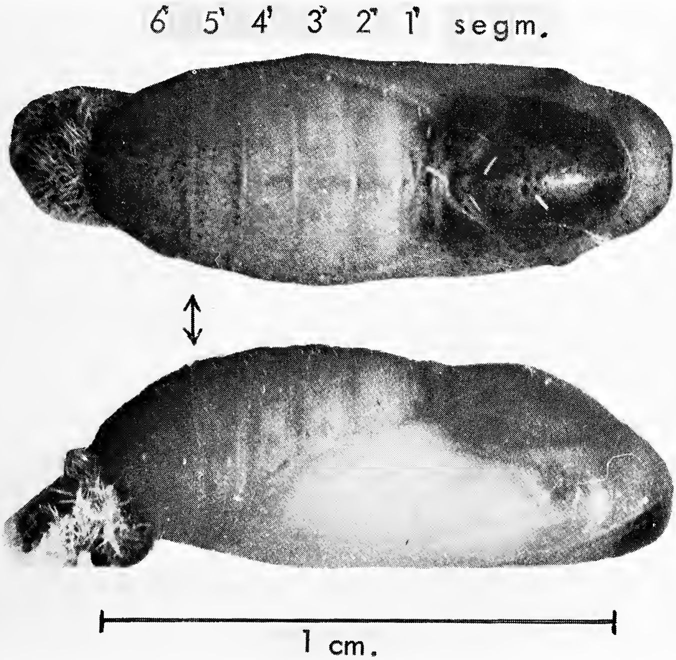


Fig. 1.—Pupa of *Aricia artaxerxes vandalica*, dorsal and lateral view.

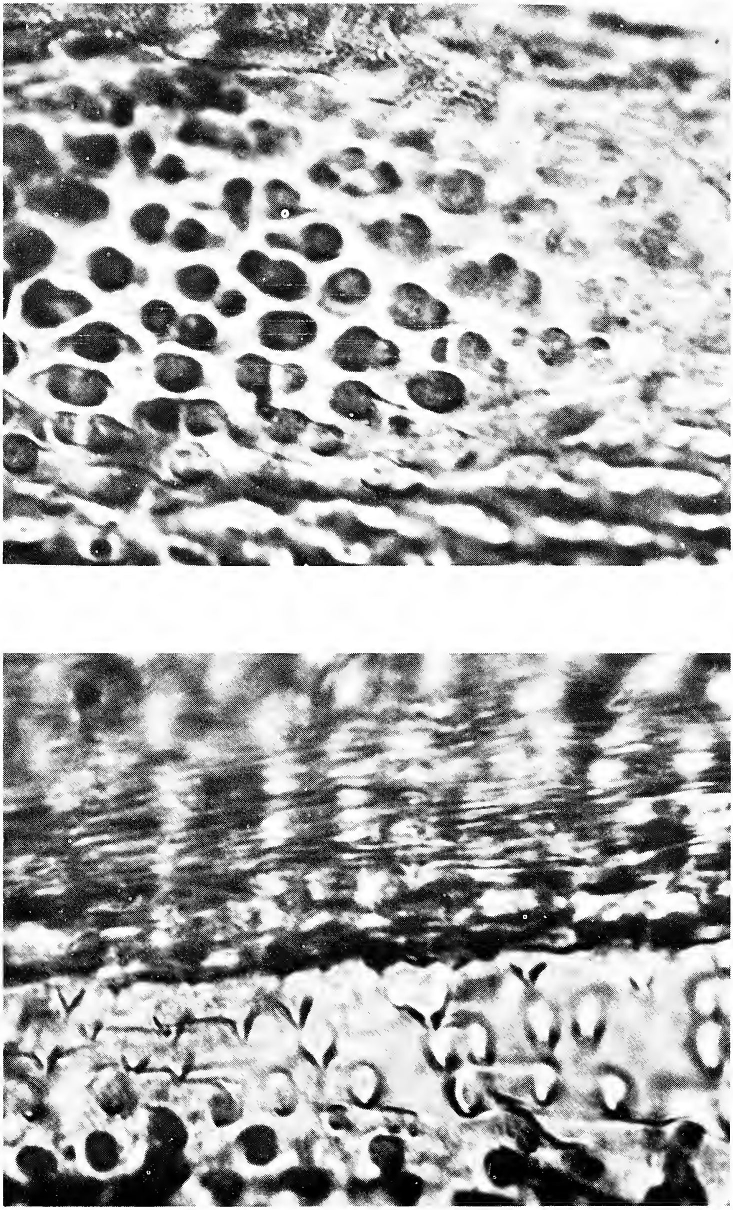


Fig. 2.—Part of stridulating organs of pupa of *Aricia artaxerxes vandalica*. From left: file, membrane and stridulating plate. Enlarged 400x.

The stridulatory devices in an *Aricia* pupa is seen Fig. 2. The stridulating "plate" in both species is on the anterior part of the intersegmental cleft (on the posterior infold of segment 5). It has a typical grained appearance, resembling very much the creased areas in old shoe leather. This "plate" is not very heavily sclerotized, rather less than the segments, and is defined more by the rough grained texture rather than by its colour. The plate extends laterally only to about the region of the spiracles. In some regions, particularly dorsal, the raised "grains" become elevated and may be defined as rounded tubercles. They are not pointed however, as are the teeth on the posterior inflection (anterior part of segment six). A rather unique feature of both of these species, not found in other Lycaenid genera, is that there is a suggestion of a grained plate and teeth between segments 6/7 as well as 5/6. Often in other species the teeth are present in relatively the same position between several segments, but the *plate* is usually lacking.

Concerning the posterior teeth (which are rubbed across the grained plate to produce the sound): they are of irregular size (some smaller than others) and of indefinite geometric arrangement, even though there is a tendency to occur in oblique alignment (=rows). (Description by Downey, i.l.)

Correspondence between visual and auditory observations

If a pupa was observed with suitable magnification, when sound production took place, it was seen, that there was a movement (an opening and closing of the cleft between segments 5 and 6), corresponding in length to a pulse in the sonagram, and then a short interval, after which the movement was repeated several times, synchronizing with the sound, mostly with a total duration of 300-700 millisec.

The correspondence between visual and auditory observations was very clearly demonstrated, when a videotape through a microscope was used.

In other words, concerning the periodical pulse-trains in these Lycaenids there was no question of "extremely rapid movements" having been observed. If such rapid movements take place, they can only be hidden within the fold, it then being merely the preparatory movement of the file being moved into contact with the plate which could be seen. In my opinion, however, it is the actual movement of the file against the stridulating plate which I was able to observe.

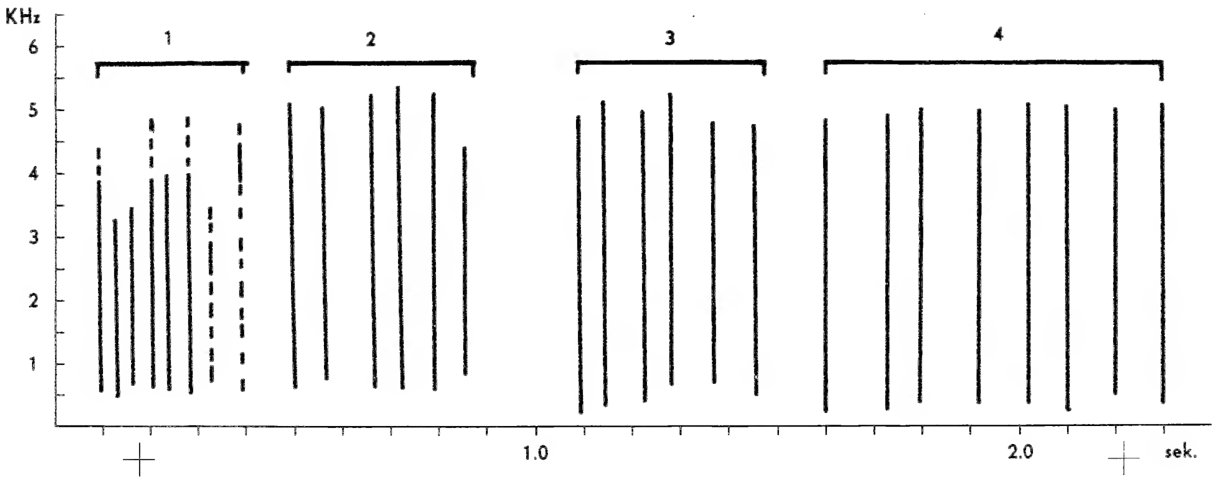


Fig. 3.—Partially schematic sonagrams of one pulse-train from 4 different pupae of *Aricia artaxerxes vandalica.*

Audiospectrograph analyses

On the basis of a tape recording (NAGRA II BH and Sennheiser microphone) a number of sonagrams have been made from individual *Aricia* pupae that have produced sounds when shaken in a jar or tickled with a brush or a human hair. After a latent period of 700 to 1300 millisec. the sonagram showed a series of sounds with a wide uniform frequency spectrum ranging up to 5-6 kHz. The sound consisted of a pulse-train (terminology from Broughton (1963)) of (4) 6-8 (10) pulses, either in rapid succession (intervals of 30 millisec.) or with longer intervals (up to 140 millisec.) The pulses in the train were seldom regular; usually they appeared in irregular succession and were of slightly varied intensity (Fig. 3). Consequently, the duration of the entire pulse-train varied and might be from 300 to 700 millisec. The pulse-train might sometimes occur as part of a short rhythmical period; for instance, having been shaken once, a pupa produced, within a few seconds, 3 pulse-trains each of 8-9 pulses at regular intervals. However, the pauses between such repeated pulse-trains were as a rule of unequal length, for instance 200-350 millisec. To judge from the construction of the sound apparatus compared with the sonagrams, it may be assumed that a pulse-train results from the pendulum movements of a plate and a file against each other corresponding to the pulses.

Oscillograph analysis of vibrations

A 10-day-old pupa of *Aricia artaxerxes vandalica* was placed on a gramophone turntable; the lightweight pick-up was balanced further and placed on the back of the pupa, and the numerous vibrations were tape-recorded and then oscillographed. The pupa reacted vigorously with pulse-trains, usually consisting of 5 pulses; the sounds were emitted both as "spontaneous" reactions to the touching of the pick-up, and when the front part of the pupa furthermore was touched with a human hair.

Fig. 4 shows an oscillogram of such a pulse-train. It appears that the wave form of individual pulses are practically identical. This especially applies to the 3 middle pulses which are also of exactly the same length. It may indicate that the same teeth of the file rub across the same irregularities on the stridulation plate.

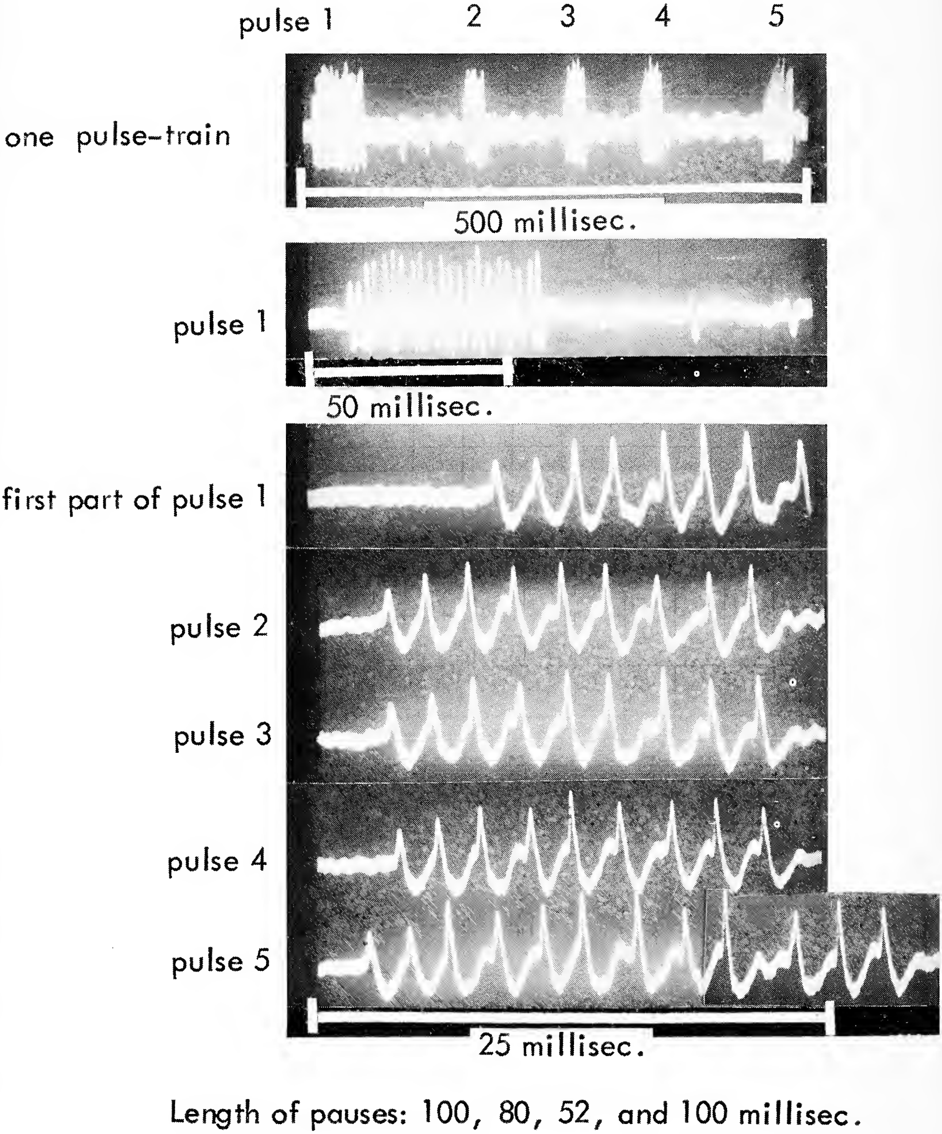


Fig. 4.—Oscillogram of vibrations of a pupa of *Aricia artaxerxes vandalica*. Upper line: one pulse-train, consisting of 5 pulses. Second line: First pulse expanded in time 4x relative to first line. Lower 5 lines: Each pulse, expanded in time 20x relative to first line.

For comparison, a sonagram (Fig. 5) was made of a corresponding pulse-train in the same recording. There is a reasonable agreement between this "vibration sonagram" and the other sonagrams recorded with a microphone; it can thus be concluded that there have been no essential resonance phenomena from the recording vials.

Most of the vibrations registered in the recording (32 pulse-trains within 150 seconds) were like those in Fig. 4. At the beginning, however, when the pupa was evidently strongly irritated, it produced a more complicated vibration (oscillogram Fig. 6) several times. If comparing this observation with the top line of Fig. 4, it turns out that the latter has 5 pulses in 500 milisec., but otherwise shows hardly any further oscillation (apart from the constant noise), while Fig. 6 has both a similar pulse-train with 6 (7) (slightly shorter) pulses within a little more than 250 millisec., and also a series of rather regular fainter vibrations, about 25 in all in 500 millisec. They start before the standard pulse-train, go on during it and continue for about 125 millisec. afterwards.

Otherwise, no similar vibrations were registered in the experiments, neither by direct listening nor in the sonagrams, probably due to the extremely low sound pressure level. They may come from a different part of the pupa, possibly from the trace of the stridulatory organs which, as stated earlier, Downey (i.l.) found in the intersegmental cleft 6/7 in *A. artaxerxes vandalica* (and *A. agestis*).

Sounds provoked by external agitation (and other stimuli)

The sound produced is so faint as only to be audible if the pupa is placed in a small vial which is held close to the ear and shaken or tapped. The sound also is provoked if the pupa is touched or faintly tickled with a brush or a short hair (or by other insects and spiders).

The sounds from Lycaenid pupae have been variously described as "chirping," "creaking," "ticking," "buzzing," "humming," or "clicking" noises. To me the sound from *Aricia* pupae resembles the creaking of a door or the far distant chattering of a magpie. With a sensitive microphone at a distance of 1-2 cm it could easily be recorded.

Sound pressure of pupal sounds

An attempt was made to get a quantitative measure of the strength of the emitted sounds. Basically this was achieved by

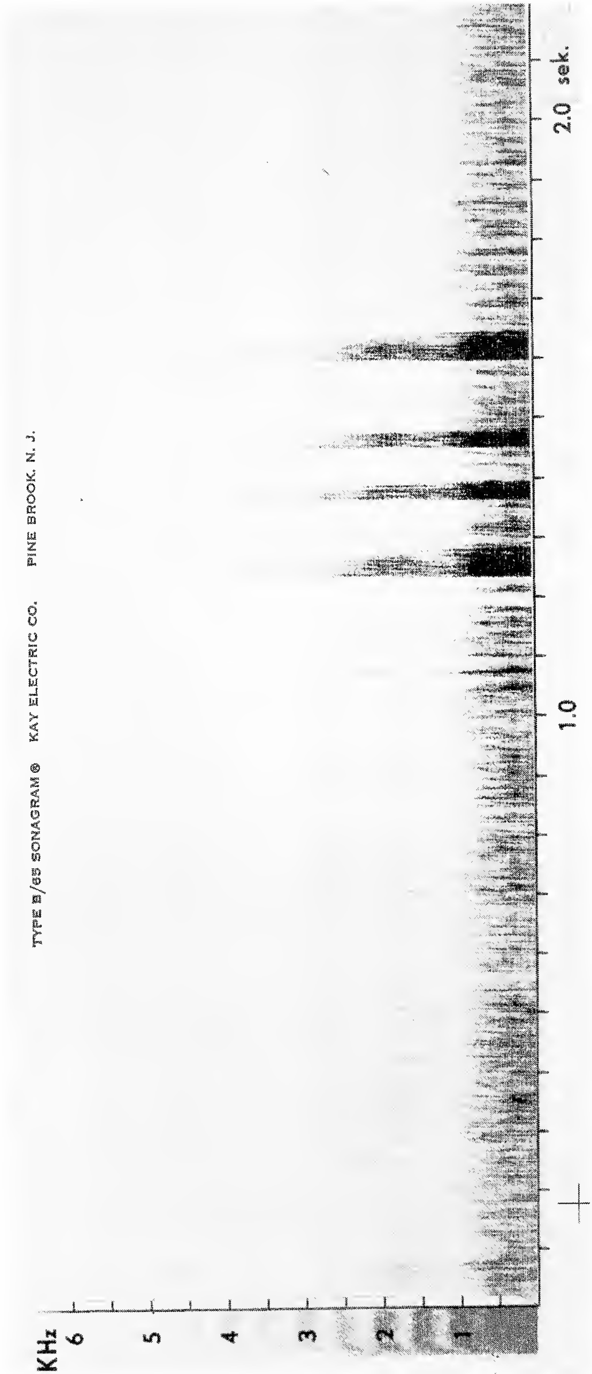


Fig. 5.—Sonagram from tape with vibrations of the same pupa as used for Fig. 4.

establishing the relationship between the sound pressure, acting on the microphone and the corresponding voltage at the output of the tape recorder during playback, using the same settings of the tape recorder controls as in the pupal recordings. This calibration was done against a Brüel & Kjaer 4135 microphone, 2619 preamplifier and a 2606 measuring amplifier.

Once this relationship was established, the recorded pupal sounds were displayed on a Hewlett-Packard 1201 A storage oscilloscope, where the peak voltage was measured. As the sounds were heavily overlaid with noise, correction was made for this, using parts of the record with no pupal sounds as a reference.

The estimate arrived at was 38 dB relative to $2x10^{-4}$dyn/cm^2 at a distance of 1 cm. Several sources of errors are apparent in this procedure, above all the rather non-reproducible sound field in the recording jar, the effect of which is likely to cause an overestimate of the actual strength of the sounds. Ever so, the figure does show that these sounds are very faint indeed and only audible at extremely short range under quiet conditions.

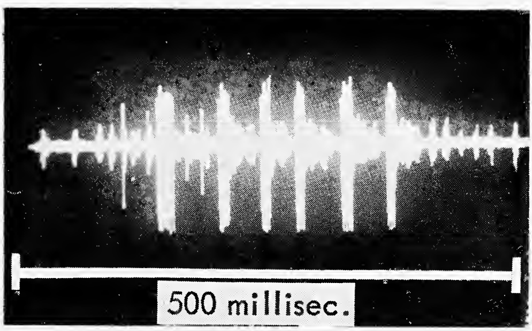


Fig. 6—Oscillogram of vibrations of the same pupa as used for Figs. 4 and 5, showing two sets of vibrations, the minor ones consisting of pulses before, during and after the standard pulse-train. (Distorted, due to overload of tape.)

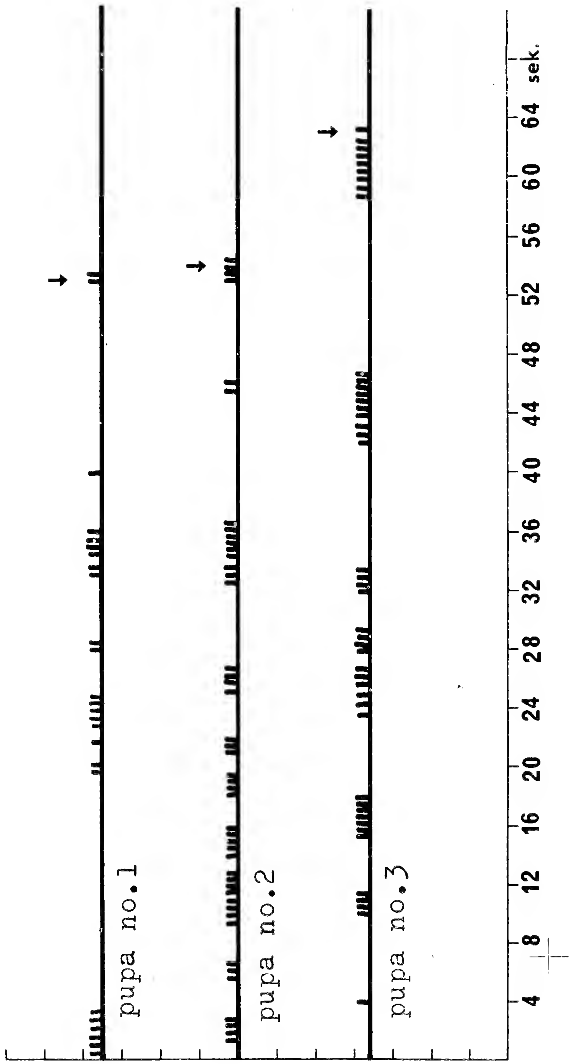


Fig. 7.—Spontaneous sounds, recorded by hand from a tape, from 3 pupae of *Aricia artaxerxes vandalica* during the last minute before emergence. At ↓ the pupal skin bursts.

Sounds and various circumstances

a) Sound and pupal age. It was found that from the (3rd-) fourth day faint sounds could be made; during the last 10 days sound production was at its maximum; the sounds could be heard every day and remained constant as to both volume and character. Sounds could be emitted until the very moment the imago emerged (see later).

b) Sound and individual, sex. Willingness to emit sounds varied form one pupa to another, but there was very little variation in the noise made by each individual pupa. The majority were willing enough throughout the 10 days, but some seemed to require some stimulus to start them off, while others made no sounds at all. If a pupa had been left in peace for many days it took a greater number of shaking movements to start off sound production. Excessive irritation could tire the pupae, making them silent for a time. The sounds from males and females were identical.

c) Sound and temperature. Sound production was found to increase with a rise in the temperature.

d) Sound and situation of the pupa. The situation of the pupae, be it inside its web within a withered leaf, or able to roll about freely, had no influence (excluding any surmise that sound-production might be connected with an attempt by the pupa to right itself).

e) Sound, and noise, light, and smell. No sounds were produced while the pupae were exposed to loud noise, strong light or smell, (a piercing "cri-cri" sound from a toy cricket; a nitraphot lamp lighted for a few seconds at a distance of 15 cm; lactic acid or oil of cloves smeared on a glass rod near the pupa).

Spontaneous sounds

The pupae did, however, make spontaneous noises. From a tape recording from a vial containing 14 five-day old pupae (which had previously all produced audible sounds when shaken), placed in the dark, at normal room temperature and in absolute silence, it was found that in the course of 15 minutes 2 sounds were made at long intervals, each consisting of one pulse-train of normal type; this corresponds to an average of one sound per pupa every 105 mins. The frequency of sounds emitted was found to increase towards the end of the pupal stage,

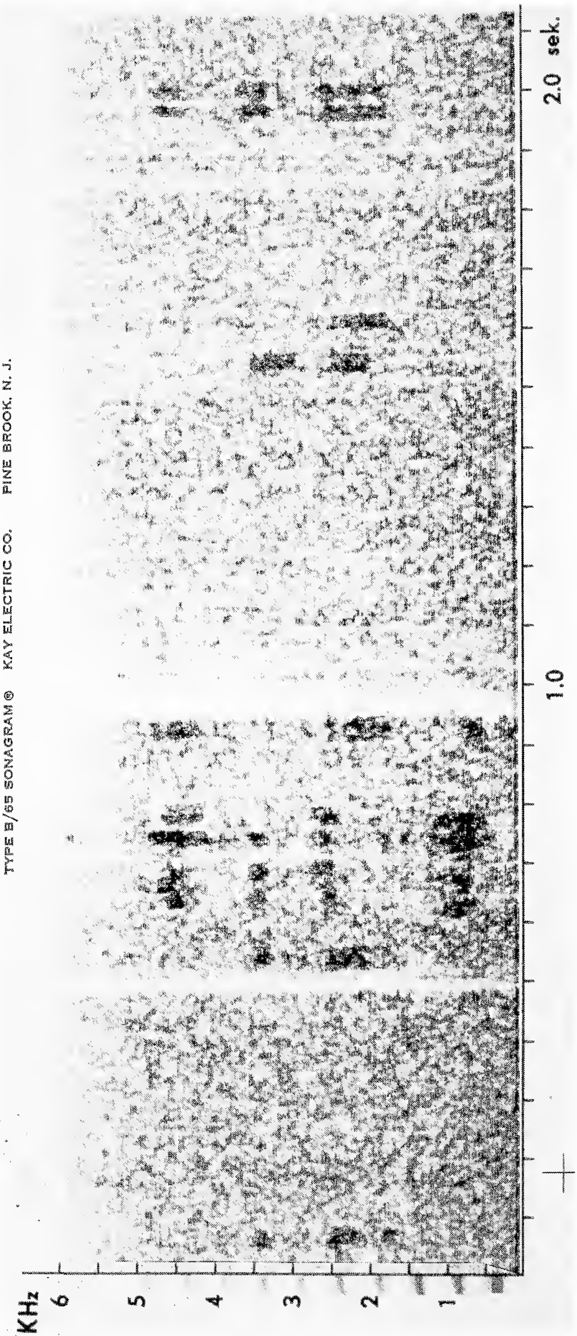


Fig. 8.—Sonagram of spontaneous sounds from an emerging *Aricia artaxerxes vandalica*, showing different pattern of pulses.

in the last hours being one sound per pupa every 3 minutes, and ending with a long sequence of sounds during the last minute before emergence (Fig. 7). This sequence started about a minute before the pupal skin bursts; at that moment some few last sounds could be recorded, and 15-30 seconds later the legs were out. The pulse-trains were formed in a different way than the normal ones (sonagram Fig. 8).

STRUCTURES AND SOUNDS IN *P. icarus, P. argus, C. argiolus* AND *Th. querqus*

In principle, I found the same circumstances in the other four Lycaenid species as in the two *Ariciae*. However, while the reaction in *Ariciae, P. icarus* and *P. argus* (apart from the faint vibrations mentioned before) consisted of one kind of sound only—(4) 6-8 (10) pulses within 300-700 millisec.—I found both in *Celastrina argiolus* and *Thecla quercus* two sets of sounds of different character: Besides a sound similar to the creaking from *Aricia* pupae, here a faint buzzing at a quicker rhythm (about 14 per second) was heard, continuing for a long time. In a particularly willing *C. argiolus* it went on for hours even though the pupa was left quietly in peace. There was a great individual variation: Out of 18 *argiolus* pupae, 5 days old, only 4 emitted this sound, and only one of them continued—but then for several months—to react by this sound to any shaking action. The sonagram (Fig. 9) shows that these sounds have a narrower maximum intensity range, about 2.5-3 kHz.

FUNCTION OF SOUND

Introduction

The significance of these sounds for the Lycaenidae has been the subject of much speculation as it seems hardly credible that they have no function whatsoever, being identified as they are with a large natural family, distributed over the six major biographical regions of the globe.

The opinion has been voiced that the sounds are meaningless, being merely incidental phenomena accompanying the "gymnastic" movements of the pupae which are necessary for the internal transport of matter.

Two theories which may readily be dismissed concern the interpretation of the sounds as a signal to other individuals of the same species, in one case to larvae, as an instigation to congregation with a company of pupae (but the majority of

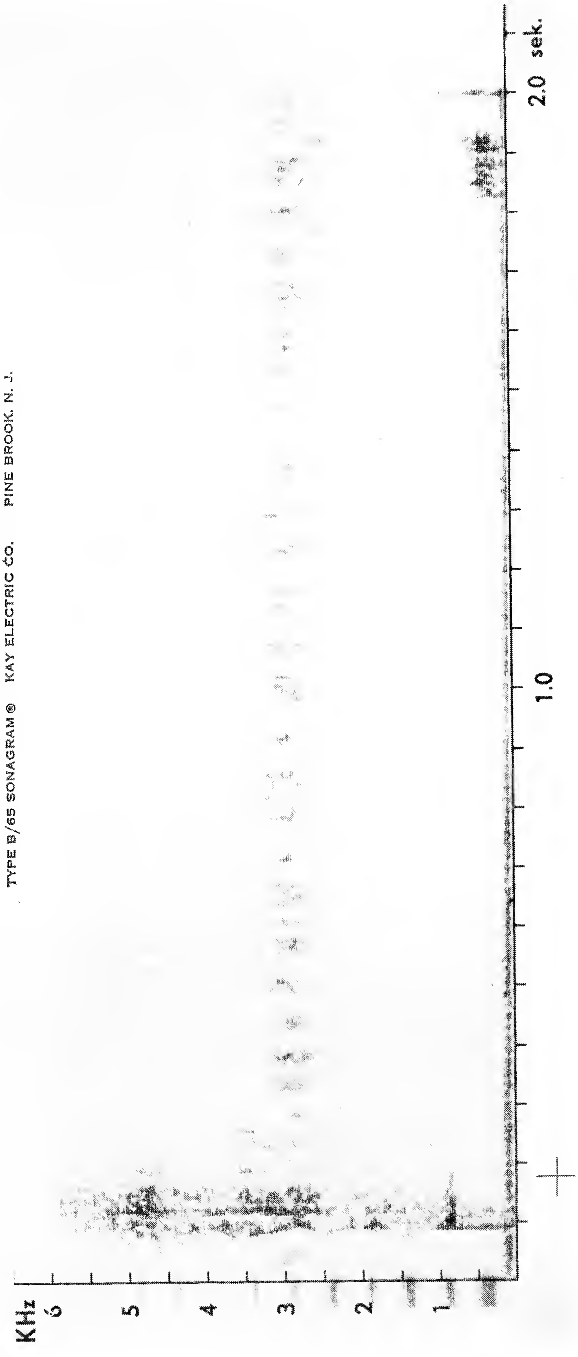


Fig. 9.—Sonagram of a pupa of *Celastrina argiolus*, showing perpetually whizzing sounds, with a maximum intensity range around 2.5-3 kHz.

Lycaenids are not gregarious) and in the other case to already emerged males, to cause them to remain in the proximity of a female pupa so as to achieve pairing as soon as the female has emerged (but this leaves unexplained the facts that some pupae make sounds months before they are mature, and that male pupae also produce sounds). In any case, butterflies have presumably no auditory sense, and such faint vibrations can certainly not be picked up at any distance by sense of touch amid the many ambient vibrations in nature.

The two theories which carry most weight are those which interpret the sounds as a defensive mechanism and those which associate them with myrmicophili.

A) The defensive mechanism theory has most adherents, although the objection has been raised that pupae are by no means so subject to predation as larvae, wherefore it should rather be the latter, which possessed the sound-production faculty; the fact that the sounds and vibrations (it must be vibrations, which are the important factor) are feeble can be no substantial objection, as a faint, unexpected buzzing can serve to scare off even humans, and a parasite or predator might well have its behaviour pattern interrupted by it.

Here I want to refer to the preceding experiment of placing a pick-up direct on the pupa; under natural conditions, the vigorous vibrations, intensified by dead leaves around the pupa, might no doubt have a deterrent effect. And the fact that the spontaneous sounds got more frequent just before the emergence may, of course, be an accidental attendant phenomenon caused by the animal's efforts to burst the pupa skin. However, it might very well be a preventive step against intruders at the coming act: This most critical period to the species and individual when the newly emerged imago always shows a nervous restlessness in its eagerness to find a resting-place where its wings can unfold and harden in peace.

B) The theory of myrmicophili (Thomann, 1901). Some of the Lycaenidae, presumably only a small minority (Malicky, 1969, 1970), live in a symbiotic relationship with ants, these protecting the larvae, feeding them, and transporting them, in some very few cases even into the ant-hill, while the larva, or in some cases even the pupa, in return yields the secretion of the exudatory gland. In such species as the last mentioned the emission of sounds (vibration) may readily be explained as a call to well-disposed ants. But it does not explain the fact that

those pupae which do not yield any secretion and that the species which have no symbiotic relationship with ants also produce such signals. The theory that it is a habit inherited from secretion-producing ancestors, and that larvae after tens of thousands of years by this means attempt to dupe ants into behaving beneficially and protectively towards them, seems hardly plausible.

With regard to the relationship of *A. agestis* and *A. artaxerxes* ssp. *vandalica* to ants, it should be mentioned that Harrison (1905) was the first to maintain that in nature, *agestis* larvae were always attended by ants. It has since been shown by Jarvis (1958-59) that ants were not so indispensible and that in artificial rearing they can be dispensed with entirely; that a simultaneous presence of *Lasius flavus* F. was purely coincidental; and that *Lasius niger* L. attacked the larva. Hoegh-Guldberg (1966) found *Formica pressilabris* Nyl., *exsecta* Nyl. and *pratensis* Retz. in the *artaxerxes* locality at Hirtshals, Jutland, Denmark, and in Jomfruland, Outer Telemark, Norway, and concluded that it must be these species which were involved in a symbiotic relationship if there was any. But both Jarvis and Hoegh-Guldberg have reared thousands of *Ariciae* without the presence of ants, and neither of them support the myrmicophilic theory.

EXPERIMENTS

In an attempt to throw light on the question, Dr. Bondesen and I enclosed, by turns, one or two specimens of presumed well-disposed ants, *Formica pressilabris* Nyl. and *F. exsecta* Nyl., with a pupa, but no sounds resulted, neither when they were in close proximity, nor—strangely enough—when they were actually touching the pupa. This was by no means the case when the same pupa was enclosed with the "hostile" *Lasius niger* L., or with *Leptothorax acervorum* F. or *Myrmica schenki* Emery. On the other hand, there was no reaction to *Formica truncorum* F. or *F. sanguinea* Latr. We did not register any stridulating sounds from the ants in these experiments. (We are indebted to Chr. Skoett, Horsens, for the procuring and determining these ants.)

These results tend to invalidate the theory of a connection between sound production and myrmicophili and speak in favour of a theory of sounds being a defensive mechanism, the more so since we were able to induce strong sounds by touching

the pupa with a brush or a human hair, or by enclosing it with a beetle (by turns *Pterostichus melanarius* Illig. (*vulgaris* L.), *Carabus granulatus* L. and *Coccinella 7-punctata* L. and with a common earwig, *Forficula auricularia* L.). In all these cases strong sounds were produced and invariably so immediately the strange insect touched the pupa. (A noteworthy phenomenon was observed when a small spider cautiously approached a pupa about 10 days old, at which age the dark eyes can be seen clearly through the pupal skin; when the spider was 1½ cm. away, two marked sounds were heard from the pupa.)

The experiments consequently have shown the reaction of Lycaenid pupae to some other animals. The experimental conditions oppositely did not permit observation of any reaction of insects or spiders to pupal sounds and vibrations—here is a field for future research.

FUNCTION OF SOUND

Overall result:

The pupal sounds in the Lycaenidae examined most likely can be interpreted as a defensive measure against other predating insects; however, it is hardly the faint oscillations in the air that deter, but rather vibrations that are transmitted through the underlay. To birds these phenomenons probably may act as attraction, if they are perceived (cf. earthworms eaten by blackbirds); but this disadvantage has to be estimated against the larger danger from parasites.

ACKNOWLEDGMENT

I am grateful to Dr. Poul Bondesen and Mr. Bertel Moehl, Natural History Museum and Zoological Institute, Aarhus, Denmark, for recording and interpretation of the sonagrams and oscillograms; to Mr. C. Mathiesen, Fona, Aarhus, for assistance and loan of the apparatus for video tape recording; and to Mrs. Merete Thaarup Jepsen and Mr. Ole Gjermandsen for photographs and reproduction of sonagrams.

Thanks are also due to Mrs. Olga Vilstrup and Mrs. Dorthe Wehl, Aarhus, and to Mr. F. V. L. Jarvis, B.Sc., F.R.E.S., Bognor Regis, England, for making the English translation.

Special acknowledgment is made to Professor J. C. Downey, Cedar Falls (Iowa), for directing my attention to these problems and for the description of anatomical details in the stridulatory organs of Ariciae; and to Mr. Björn Petersen, Malmö, Sweden, for criticism and correction of the manuscript.

SUMMARY

1) Even though the ability to produce sounds in Lycaenid pupae has been known for 200 years, there seems to be a want of experimental work with live pupae.

2) In *Aricia artaxerxes* F. and *A. agestis* Schiff. was found a suggestion of stridulatory organs between segments 6 and 7 too.

3) Under different conditions, numerous experiments with tape recorder, sonograph, oscillograph, and video-tape have been carried through on pupae of 6 different Danish Lycaenid species, preferably *Aricia artaxerxes* which were considered particularly suited.

4) A movement of the intersegmental cleft 5/6 corresponded to the duration of a pulse in a pulse-train—there are consequently no extremely rapid movements.

5) The sonagram showed a series of sounds with a wide uniform frequency spectrum, ranging up to 5-6 kHz.

6) Besides, a continuous whizzing sound with a lower intensity range was found in *Celastrina argiolus* L. and *Thecla quercus* L.

7) The vibrations in *A. artaxerxes* were analyzed by oscillography, and such a similarity between the wave form of the single pulses in a pulse-train was found that they may be regarded as produced by a movement of the same teeth of the file against the same irregularities in the stridulating plate.

8) By an oscillograph analysis 2 sets of vibrations were found in *A. artaxerxes,* the usual ones, but also a series of fainter vibrations starting before the main pulse-train, going on during it, and ending afterwards. They may come from the intersegmental cleft 6/7.

9) The sound pressure of the usual signal was gauged to 38 dB relative to $2\text{x}10^{-4}\text{dyn/cm}^2$.

10) The pupae emitted sounds from the time they have hardened, a few days old, and until the moment of emergence. There was an individual difference as to how easily sounds are provoked, they were alike in ♂ and ♀, independent of the situation of the pupa, increasing by raising temperature, not emitted by influence of noise, strong light, and pungent smells. They were only produced by shaking and touching.

11) Also spontaneous sounds occurred, increasing in number until the emergence, just before which there was a long series of sounds. The sonagram showing these emergence sounds differs from the normal sonagrams.

12) The theories on the function of the pupa sounds were examined. A series of experiments did not support the myrmicophilic theory; but the experiments will support the theory that the sounds—vibrations—serve as a defensive measure; and the emergence sounds might be a preventive arrangement in order to keep predators away before this most critical hour in the insect's life.

LITERATURE CITED

BROUGHTON, W. B., 1963. In BUSNEL, R.-G.: Acoustic behaviour of animals, p. 3-24.

DICKSON, C. G. C., 1952. The life history of *Phasis zeuco zeuco* L. *Trans. Roy. Soc. So. Africa,* 33(4):447-456.

DOWNEY, John C., 1966. Sound production in pupae of Lycaenidae. *Jour. Lepid. Soc.,* vol. 20(3) p. 129-155.

———— 1967. Sound-production in Netherland Lycaenidae. *Ent. Ber.,* 27, p. 153-157.

HARRISON, J. W. H., 1905. Observations on *Polyommatus astrarche. Ent. Rec.* 17, p. 267.

HINTON, H. E., 1948. Sound production in lepidopterous larvae. *Entomologist,* 81: 254-269.

———— 1946. Concealed phases in the metamorphosis of insects. *Nature,* 157: 552-553.

HOEGH-GULDBERG, OVE, 1966. North European Groups of *Aricia allous* G.-Hb. Their Variability and Relationship to *A. agestis* Schiff. *Aricia* studies 6 (*Natura Jutlandica* 13) Aarhus.

JARVIS, F. V. L., 1958-59. Biological Notes on *Aricia agestis* (Schiff) in Britain, Part I-II-III. *Ent. Rec.* 70-71, p. 1-18, 169-178.

MALICKY, H., 1969. Versuch einer Analyse der ökologischen Beziehungen zwischen Lycaeniden (Lepidoptera) und Formiciden (Hymenoptera) *Tijdschrift voor Entomologie,* 112: 213-298.

———— 1970. New aspects on the association between Lycaenid larvae (Lycaenidae) and ants (Formicidae, Hymenoptera). *Jour. Lepid. Soc.* 24: 190-202.

PRELL, H., 1913. Über zirpende Schmetterlingspuppen. *Biol. Centralbl.* 33: 496-501.

STRAWN, M. A., 1964. Sound production in pupae of the butterfly family Lycaenidae. Unpublished Masters Thesis, Southern Illinois University.

THOMANN, H., 1901. Schmetterlinge und Ameisen. Beobachtungen über eine Symbiose zwischen *Lycaena argus* L. und *Formica cinerea* Mayr. *Jahresber. Nat. Ges. Graub.* 44: 1-40.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

REVIEW

Jamaica and its Butterflies. F. Martin Brown and Bernard Heineman. 1972. i-xv, 1-478, 10 color plates. E. W. Classey Limited, London.

North American Distributor: Entomological Reprint Specialists. P. O. Box 77971, Dockweiler Station, Los Angeles, California 90007. U.S.A. $44.00.

This beautifully printed volume covers the butterflies of the Caribbean island Jamaica with a detail which is commendable. In addition to the usual description of the species, together with pertinent nomenclatorial comments, there are sections of the book preceding these, covering, (a) the general ecological scene (Chapt. 1), early collectors (Chapt. 2), present day collecting (Chapt. 3), butterfly anatomy and biology (Chapt. 4), butterfly habitats of Jamaica (Chapt. 5) including indispensible ecological maps of the island and zoogeography (Chapt. 6) giving a faunistic comparison with other Caribbean islands and the mainland. Following these very useful sections 14 families of butterflies are described and figured. There is a fine, apparently complete bibliography.

This reviewer has no negative comments to make. It is characteristic of much present day terminology to fail to distinguish between what is new and what is right. This book is not the first time that the names *Argynnis* and *Speyeria* have become twisted recently: "Euptoieta as a genus . . . nor of its position close to Argynnis (s.l.) and through that Old World genus, to the silver-spotted *Speyeria* of the *New* and *Old World.*"

W. Hovanitz

Journal of Research on the Lepidoptera 10(2):149-180, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A REVIEW OF THE GENUS *LASAIA* (RIODINIDAE)

HARRY K. CLENCH

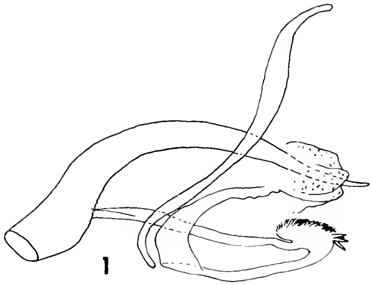
Carnegie Museum, Pittsburgh, Penna. 15213

Lasaia IS A PARADOX. The genus itself is readily and accurately recognized and generic identification has given almost no trouble to anyone. Its species, on the other hand, have been a continuing source of misunderstanding and misidentification.

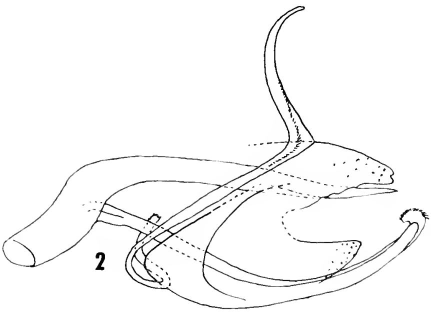
It is not clear what the difficulty has been. The species do run close, but many butterfly groups are just as difficult and have not given comparable trouble. Females are scarce and even now remain unknown in some species, but males are common enough and the taxonomy still relies chiefly on them. Whatever the reason, it is unfortunately true that no published work is able to give even approximately correct identification of most of the species. The present review, in fact, grew out of my frustration in trying to find accurate names for the *Lasaia* that occur in Mexico and the United States. It was soon evident that this could be achieved only by studying the genus in its entirety.

Acknowledgements. For the loan of specimens for study I am grateful to: Dr. H. J. Hannemann, Museum für Naturkunde der Humboldt Universität, Berlin; Mr. Bryant Mather, Jackson, Mississippi; Dr. Lee D. Miller, Allyn Museum of Entomology, Sarasota, Florida; Mr. Herman Real, San Mateo, California. Dr. Frederick H. Rindge, American Museum of Natural History, New York, made available the rich material of that institution during my recent visits there. Dr. Jean Bourgogne, Museum National d'Histoire Naturelle, Paris, and Mr. D. S. Fletcher, British Museum (Natural History), London, both provided photocopies of the rather involved original description of *L. agesilas,* and Mr. Fletcher also sent color transparencies of the original illustrations. Mr. F. Martin Brown, Colorado Springs, Colorado, during one of his visits here, made the photogaphs that illustrate this paper. I thank all these gentlemen for their valued assistance.

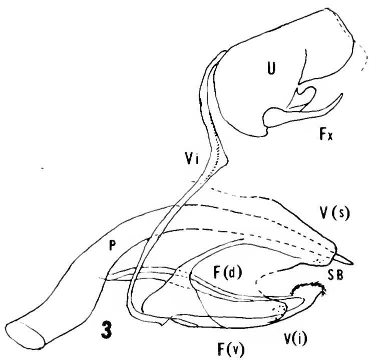
Most of the abbreviations used in this paper are readily understandable. A few require explanation: TL, type locality; adt, adterminal; st, subterminal; pm, postmedian (these three all referring to individual spot rows on the wings); fw, fore wing; hw, hind wing; up, upperside; un, underside (these two and the preceding two also used in combination, as upfw, unhw); *leg., legit* [collected by]; coll., in the collection of; *ex coll.,* from the collection of. Repositories of material examined are abbreviated as follows: AME, Allyn Museum of Entomology, Sarasota, Florida; AMNH, American Museum of Natural History, New York; CM, Carnegie Museum (including specimens received from ANSP, Academy of Natural Sciences, Philadelphia).



1



2



3

Fig. 1.—*Lasaia moeros moeros* Staudinger, ♂ genitalia, uncus omitted, slide C-1206. Peru: Sani Benj, 840 m, 1-7.ix.1935, *leg.* F. Woytkowski, CM.

Fig. 2.—*Lasaia sessilis* Schaus, ♂ genitalia, uncus omitted, slide C-1210. México: Veracruz: Fortin [de las Flores], 5.xii.1957, *leg.* B. Mather, CM.

Fig. 3.—*Lasaia maria maria* n. sp., ♂ genitalia, including uncus, slide C-1208, paratype. México: Jalisco: Ajijic, 3.ix.1966, *leg.* R. G. Wind, CM. Identification of component structures: U, uncus; Fx, falx; Vi, vinculum; P, Penis; V(s), valva: processus superior; V(i), valva: processus inferior; F(d), frenum: dorsal arm; F(v), frenum: ventral arm; SB, scobinate bulla.

Lasaia Bates

Lasaia Bates 1868, J. Linn. Soc. Zool. 9: 397. Type species *Papilio meris* Stoll [1781], by subsequent selection (Stichel 1910, Gen. Ins. 112 A: 184, 185).

Talites Capronnier 1874, Ann. Soc. Ent. Belge 17: 20. Type species *Papilio meris* Stoll [1781], by subsequent selection (Hemming 1935, Stylops 4: 2).

On the basis of wing configuration, pattern, color, size and male genitalia the genus divides readily into five species groups, containing up to three species each. The *moeros* and *sessilis* groups stand somewhat apart from the remaining three groups, and from each other as well.

The male genitalia of *Lasaia* (figs. 1-7) are uniform in general plan throughout. They consist of a contorted ring-like vinculum, a dorsal posterior uncus (omitted in all figures but fig. 3), a pair of modified posterior valvae, and a simple penis attached to the ventral vinculum by a heavily sclerotized frenum. The frenum is apically modified into a peculiar scobinate bulla. There is no saccus.

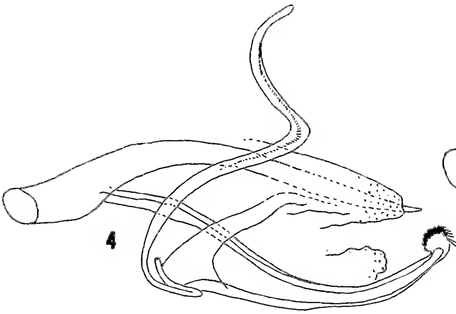
The *vinculum* (fig. 3, Vi) is uniformly narrow and strap-like. Laterally it is angled abruptly (*lateral angle*), usually strongly. The lateral angle divides each side into a *dorsal segment* and a *ventral segment*. Middorsally and midventrally the vinculum is posteriorly excurved, the dorsal loop fitting into an invagination of the proximal margin of the uncus.

The *uncus* (fig. 3, U) is massive, subquadrate, obscurely bilobed posteriorly, and laterally is provided with a pair of U-shaped, blunt-tipped falces (Fx). The uncus is relatively uniform in structure throughout the genus and is therefore omitted from all the figures but fig. 3.

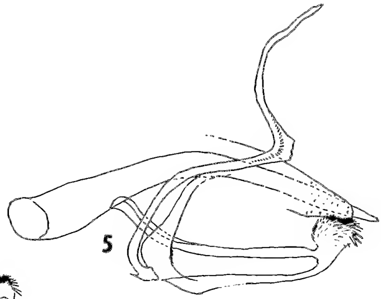
Each of the paired *valvae* consists of a *processus superior* (fig. 3, V(s)), setose and moderately sclerotized apically, the two apparently united to each other dorsally and forming a sort of trough or guide for the penis; and a *processus inferior* (fig. 3, V(i)), apically setose and rounded, but very lightly sclerotized and often hard to see. The proximal parts of the valvae are membranous and impossible to study in detail save for an elongate, erect, triangular-shaped, sclerotized piece that arises on the base of the ventral arm of the frenum and extends dorsally to the processus superior, its union with the latter being obscure.

The *penis* (fig. 3, P) is a simple, elongate, downbent structure, tapering distad to a blunt point. It lacks cornuti.

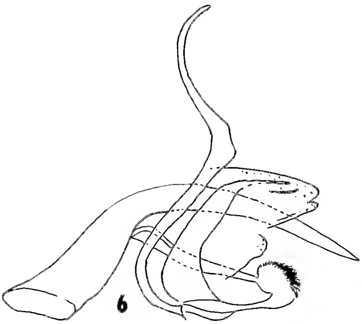
The *frenum* in *Lasaia* is a complex strap that connects the penis with the ventral vinculum. It consists of a *dorsal arm* (fig.



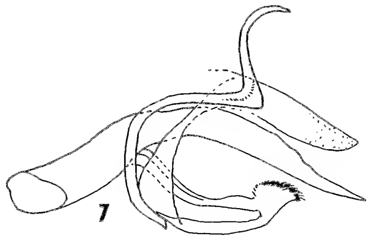
4



5



6



7

Fig. 4.—*Lasaia arsis* Staudinger, ♂ genitalia, uncus omitted, slide C-1209. Bolivia: Rio Yapacani, 600 m, ii.1915, *leg.* J. Steinbach, CM.

Fig. 5.—*Lasaia pseudomeris* n. sp., ♂ genitalia, uncus omitted, slide C-1211, paratype. Bolivia: Rio Surutu, 350 m, iii.1915, *leg.* J. Steinbach, CM.

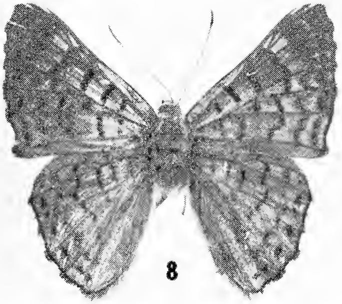
Fig. 6.—*Lasaia agesilas callaina* n. ssp., ♂ genitalia, uncus omitted, slide C-1205, paratype. México: San Luis Potosí: Cd. Valles, 9.vi.1966, *leg.* H. A. Freeman, CM.

Fig. 7.—*Lasaia sula peninsularis* n. ssp., ♂ genitalia, uncus omitted, slide C-1212, paratype. México: Yucatán: Pisté, viii.1952, *leg.* E. C. Welling, CM.

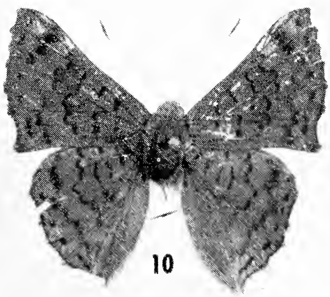
3, F (d)), a band that arises on the ventral surface of the penis near its base and extends posteriorly beyond the valvae to end in the scobinate bulla; and a *ventral arm* (fig. 3, F(v)) which arises on the ventral vinculum and extends posteriorly to end also in the scobinate bulla. The ratio of the length of the dorsal arm to the length of the penis is taxonomically useful and is given for most species. In other riodinids the frenum is a simple looped strap that extends posteriorly from the penis, then curves around to end on the vinculum: the dorsal and ventral arms being defined simply by position, with no scobinate bulla present. The *scobinate bulla* (fig. 3, SB) in *Lasaia* appears to be an elaborate modification of the bend in this simple type, for intermediate states of development can be found in other genera. The bulla is an expanded, rounded knob, provided with a dense pile of fine spiculae on the dorsal part, the spiculae directed posteriorly and generally tending to become larger toward the posterior part of the bulla. The scobinate bulla exists in two types in *Lasaia*: *rounded,* the ventral margin regularly convex and curving around to the dorsal; and *flared,* the ventral margin slightly recurved and hence concave in lateral view. These two types are distributed in a curious way within the genus. In the *sessilis* group, the bulla is rounded in *sessilis,* flared in *maria;* in the *arsis* group it is rounded in *arsis,* flared in *pseudomeris;* and in the *agesilas* group it is rounded in *agesilas,* flared in *sula.*

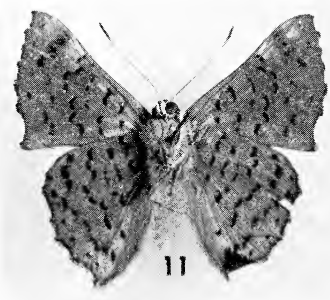
In general the genitalia provide good species characters, and they also provide some traits that support the higher groupings based on external characters. Because of the firm union of the penis and the ventral vinculum, *via* the frenum, and because of the complex structure and light sclerotization of the valvae, as well as the contorted form of the vinculum, it is impossible to show the structures well in any sort of dorsal or ventral view, or to dissect the components to show them separately. They are best studied in a whole (undissected) lateral mount.

The genus *Lasaia* is exclusively Neotropical and occurs mostly in the Tropical and Subtropical life zones. In low latitudes, where the annual temperature cycle is of small amplitude, some species may occur upward into the Lower Austral zone, and a few are found even in the Upper Austral. According to Godman & Salvin they prefer more or less open, thinly wooded areas (presumably open forest, savanna and scrub) and are often found associated with sandy or gravelly places along streams. They are powerful fliers but they visit flowers readily and may be captured at them without difficulty.

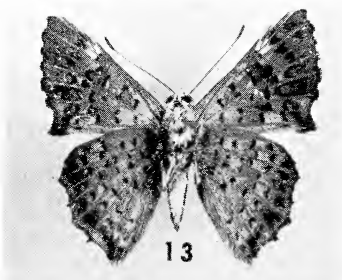

8


9

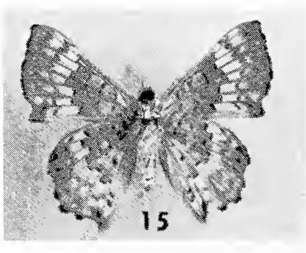

10


11


12


13


14


15

In the Andean region six species occur (*moeros, arsis, pseudomeris, aerugo, agesilas, oileus*), a larger number than is known from any other area of comparable size and diversity anywhere. Surprisingly, the second largest number, five species (*sessilis, maria, sula, agesilas, oileus*), is found in the relatively small region that includes southern Mexico, Guatemala and British Honduras. In most other areas no more than three species are found. The southernmost limit of *Lasaia* is in Paraguay and southeastern Brasil; the northernmost is in southern Texas. No member of the genus has been found in the West Indies.

SYNOPSIS OF SPECIES

A. *moeros* group

1. moeros Staudinger 1888
   a. moeros Staudinger 1888
      rosamonda Weeks 1900
   b. kennethi Weeks 1901
      merita Godman 1903
      pura Seitz 1917

B. *sessilis* group

2. sessilis Schaus 1890

3. maria n. sp.
   a. maria n. ssp.
   b. anna n. ssp.

C. *arsis* group

4. arsis Staudinger 1888

5. meris Stoll 1781

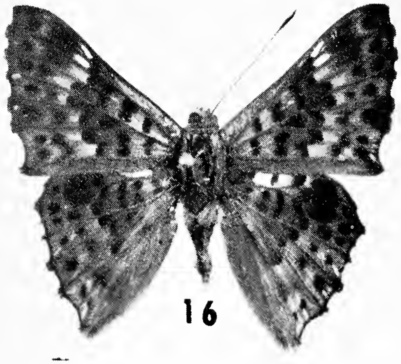
6. pseudomeris n. sp.

D. *agesilas* group

7. sula Staudinger 1888
   a. peninsularis n. ssp.
   b. sula Staudinger 1888

8. aerugo n. sp.

Fig. 8.—*Lasaia moeros moeros* Staudinger, ♂ upperside. Peru: Sani Benj, 840 m, 1-7.ix.1935 (F. Woytkowski).
Fig. 9.—Same specimen, underside.
Fig. 10.—*Lasaia sessilis* Schaus, ♂ upperside. México: Veracruz: Córdoba, *ex coll.* ANSP, CM.
Fig. 11.—Same specimen, underside.
Fig. 12.—*Lasaia maria maria*, n. sp., ♀ upperside. Holotype.
Fig. 13.—Same specimen, underside.
Fig. 14.—*Lasaia maria maria*, n. sp., ♀ upperside. Paratype: México: Jalisco: Ajijic, 5400 ft., 17.xii.1966 (R. G. Wind).
Fig. 15.—Same specimen, underside.



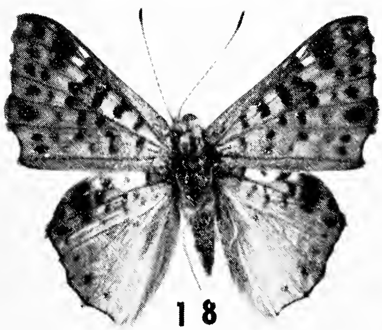


Fig. 16.—*Lasaia arsis* Staudinger, ♂ upperside. Lectotype.
Fig. 17.—Same specimen, underside.
Fig. 18.—*Lasaia pseudomeris*, n. sp., ♂ upperside. Holotype.
Fig. 19.—Same specimen, underside.

9. agesilas Latreille 1809
   a. esmeralda n. ssp.
   b. agesilas Latreille 1809
      narses Staudinger 1888
   c. callaina n. ssp.

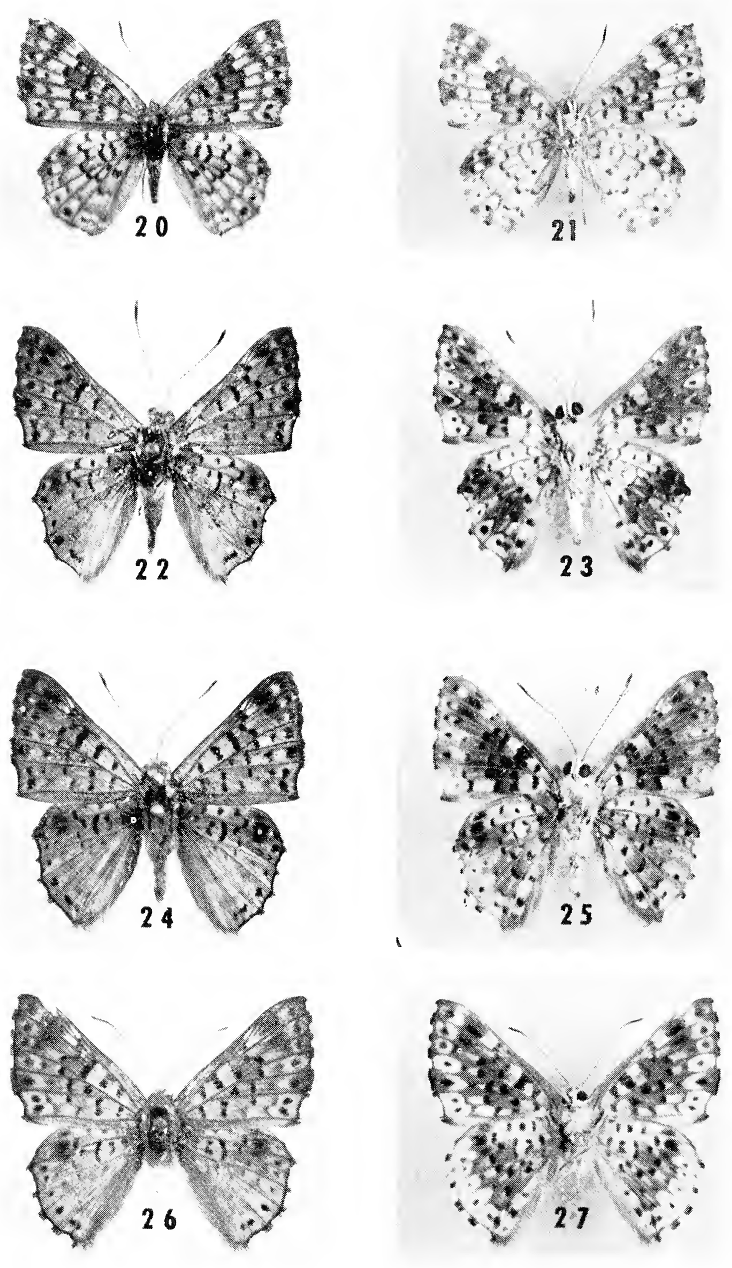
E. *oileus* group

10. oileus Godman 1903

11. scotina Stichel 1910

KEY TO SPECIES

1. a. Small: length of fw 11 mm or less; up mostly brown, with little or no blue in either sex 10
   b. Larger: length of fw 12 mm or more; ♂ up usually shining green or blue, less often bronze brown or steel blue; ♀ may or may not have some blue above 2
2. a. Uphw (♂ only; no ♀ seen) with a prominent white patch in the fuscous costal area, usually enclosing a small fuscous dot 3
   b. No such patch 5
3. a. Larger, length of fw 14 mm and over, usually over 16 mm; ♂ hw margin usually straight between M_1 and M_3; ♂ hw with many fuscous or black spots on wing below M_1 + costal edge of cell, including spots in cell, the pm spot row and a row of st spots; fringe white, but fuscous checkering broad, at Cu_1 and Cu_2 nearly as broad as the white between them ....*arsis* (p. 168)
   b. Smaller, length of fw rarely exceeding 15 mm 4
4. a. ♂ uphw nearly immaculate green below M_1 + costal edge of cell; ♂ hw margin usually concave between M_1 and M_3; ♂ hw fringe almost pure white, the fuscous checkering at vein-ends hardly broader than the veins themselves....*pseudomeris* (p. 170)
   b. ♂ hw marked about as in *arsis* (cf. couplet 3.a), hw margin and fringe not known. Not seen, perhaps confined to the Guiana coast ....*meris* (p. 169)
5. a. Fw (but not hw) up and un, st line consists of a series of transverse fuscous crescents; ♂ up blue-green, shining; pm line upfw tends to be straight between costa and Cu_1; in general appearance more regularly margined, easily recognized but hard to describe ....*moeros* (p. 159)
   b. Fw, up and un, st line consists of a row of round fuscous spots, sometimes heavy; ♂ up ground variable: may be shining blue-green or dull bronze-brown or dull steel blue; pm line of fw tends to be quite irregular between costa and Cu_1; in general appearance more irregularly margined 6
6. a. Un ground (♂, ♀) uniform brown, with crisp darker brown spots and no trace of blotchy suffusions; ♂ up dark bronze with a shining bluish cast; ♀ up brown, dull, with faint darker markings ....*sessilis* (p. 164)
   b. Un ground variegated, partly brown, partly white or bluish; ♂ up steel blue or shining blue-green; ♀ up usually with variegated brown ground, usually with some bluish or greenish on part of the wings 7
7. a. ♂ up dull steel blue; ♀ up bluish fuscous with ochreous patches and a more or less pronounced pm band of whitish; ♂ un with ochreous brown ground, including the entire area distad of the st spots on both wings; a marked pm band of shining pale bluish; ♀ un similar but the band whitish ....*maria* (p. 164)


20
21
22
23
24
25
26
27

b. ♂ up shining greenish blue, ♀ up various, but without ochreous patches; un with at least part of the area distad of the st spots bluish or white on both wings 8

8. a. ♂ unhw base white, not bluish at all; ♀ unhw st line more or less parallel to termen, commonly faint in cubital region; both sexes, up and un, fuscous spotting small and often pale 9

b. ♂ unhw base fuscous or, if pale, with a distinct bluish or violet cast; ♀ unhw st line retracted (and not paler) in cubital area and therefore seeming almost straight from end of M_1 across to inner margin just basad of tornus; both sexes, up and un, spotting thick and dark ....*agesilas* (p. 175)

9. a. ♂ unhw ground distad of st line white, infuscated both costally and tornally; adt spots distinctly closer to st line than to termen; up greenish blue ....*sula* (p. 171)

b. ♂ unhw ground distad of st line white, with no such infuscation; adt spots equidistant between st line and termen: up blue ....*aerugo* (p. 173)

10. a. Underside (both sexes) ground bluish white, with fuscous spots and blotches; upfw costal white spot present just beyond pm line ....*oileus* (p. 179)

b. Underside (at least ♂) ground pale tan with dark brown minute spots; upfw with no costal white spot......*scotina* (p. 179)

A. *moeros* group

Wing termina entire, little excised between Cu_2-2A of fore wing; fringe checkering of fore wing fairly regular; lines, especially on fore wing, tending to greater regularity; fore wing subterminal line a series of transversely elongate crescents rather than rounded spots as in all other groups. The male genitalia (seen only of *m. moeros*) are distinguished from those of all other groups by the only slightly sinuate vinculum, there being almost no lateral angle. In addition the sclerotized part of the processus superior of the valva is shorter than in any other group. Females are still unknown.

1. *Lasaia moeros* Staudinger

1. a. *Lasaia moeros moeros* Staudinger (Figs. 1, 8, 9)

Lasaia Moeros Staudinger 1888, Exot. Tagfalter: 257; [not listed in Mengel 1905, Cat. Eryc.]

Lasaia m. moeros: Stichel 1910, Berliner Ent. Zschr. 55: 48 [implicit]; *ibid.* 1910, Gen. Ins. 112 A: 187; Seitz 1917, Grossschmett. Erde 5: 692 [see note below]; Stichel 1930, Lep. Cat. 26: 438.

Lasaia rosamonda Weeks 1900, Proc. New England Zool. Club 2: 45; *ibid.* 1905. Ill. Diurn. Lep. 1: 9, pl. 5; Mengel 1905. Cat. Eryc.: 109; Stichel 1910, Gen. Ins. 112 A: 187 [as syn. of *m. moeros*].

Fig. 20.—*Lasaia sula peninsularis,* n. ssp., ♀ upperside. México: Veracruz: 2 mi SE Coatzacoalcos, 18.i.1966 (H. Clench & L. D. Miller, sta. 24, CM-CUA Exp.).

Fig. 21.—Same specimen, underside.

Fig. 22.—*Lasaia sula peninsularis,* n. ssp., ♂ upperside. Holotype.

Fig. 23.—Same specimen, underside.

Fig. 24.—*Lasaia sula sula* Staudinger, ♂ upperside. Lectotype.

Fig. 25.—Same specimen, underside.

Fig. 26.—*Lasaia aerugo,* n. sp., ♂ upperside. Holotype.

Fig. 27.—Same specimen, underside.

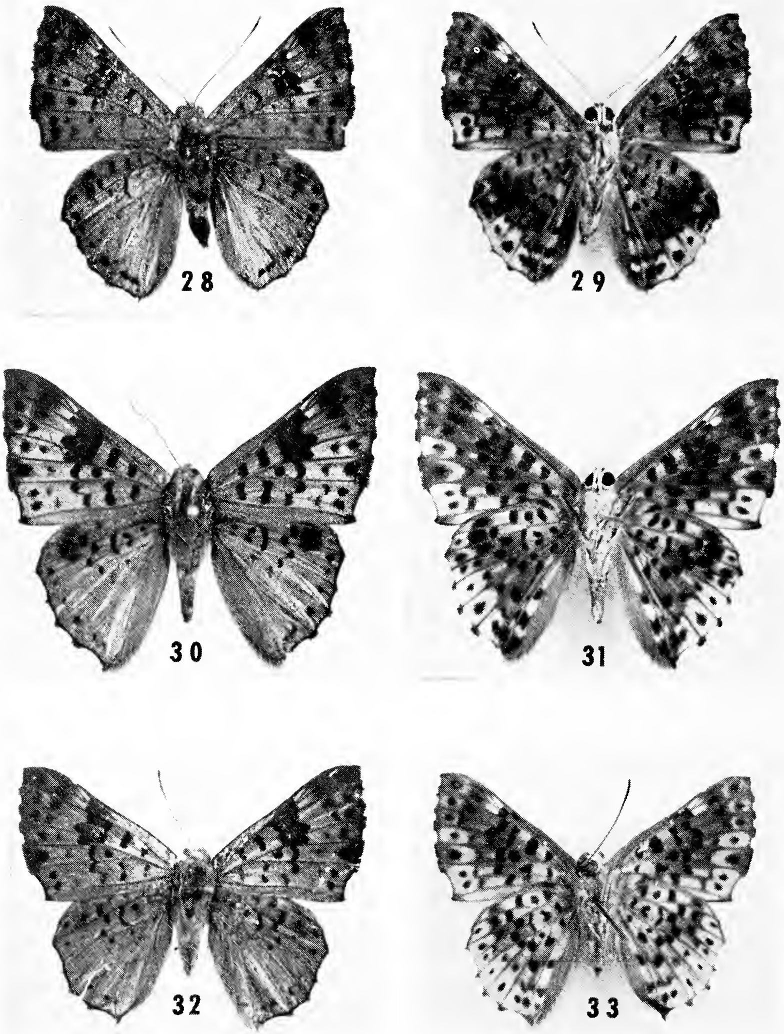


Fig. 28.—*Lasaia agesilas callaina*, n. ssp., ♂ upperside. Holotype.
Fig. 29.—Same specimen, underside.
Fig. 30.—*Lasaia agesilas agesilas* Latreille, ♂ upperside. Lectotype of *Lasaia narses* Staudinger.
Fig. 31.—Same specimen, underside.
Fig. 32.—*Lasaia agesilas esmeralda*, n. ssp., ♂ upperside. Paratype. Paraguay: Villarrica, 11.xii.1921 (P. Jorgensen).
Fig. 33.—Same specimen, underside.

Seitz badly confused the forms of this species (cf. Stichel 1930). On plate 135 h he figures both surfaces of a form he calls *pura*. In the text he synonymizes this name to *m. moeros*, but it is actually a synonym of *moeros kennethi*. The form figured on plate 135 i as *kennethi* is actually *m. moeros*. The form figured on plate 135 i as *merita* is correct (his figures appear to have been copied from Godman's), but *merita* is a synonym of *kennethi*.

Nominate *moeros* is well marked with both pm and st lines on the upperside, including the hind wing. On the hind wing underside the pm line is rather heavy and usually encloses a darker basal area; the st line is present as a series of dots or chevrons.

This form is so far known only from Colombia, Ecuador and Peru. The authentic Peruvian and Ecuadorian records are all from the eastern slope of the Andes, within the narrow range of about 850-1100 meters elevation. The Colombian records are widely disjunct (some 800 miles northward), and contrast otherwise: Muzo is west of the eastern Cordillera Oriental of the Andes, in the Magdalena drainage, but at about 900 meters; Bogotá itself is above 2000 meters and west of the Cordillera Oriental, but the actual site of collection could have been anywhere within a large radius and over a considerable range of altitude.

COLOMBIA. Boyaca: Muzo (AME).—Cundinamarca: Bogota district (TL *rosamonda*).

ECUADOR. Oriente: Puyo, 3500 ft., Rio Pastaza (AMNH).

PERU. San Martín: Riojo [=Rioja?], 900m, Rio Secol (CM).—Huanuco: Rio Pichis, 300 m; Pozuzo [ca. 900 m] (both AME).—Pasco: Rio Palcazu, Chuchuras (AME).—Junin: La Merced (AMNH); Satipo [ca. 900 m] (AME, CM).—Ayachucho: Candalada la Mar, vi. 1941 (AMNH).—Not located: Concepción (CM); "Sani Benj" 840 m (CM); Chanchamayo (TL *moeros*).

1. b. *Lasaia moeros kennethi* Weeks

Lasaia kennethi Weeks 1901, Proc. New England Zool. Club 2: 71; *ibid.* 1905, Ill. Diurn. Lep. 1: 86, pl. 36; Mengel 1905, Cat. Eryc.: 109.

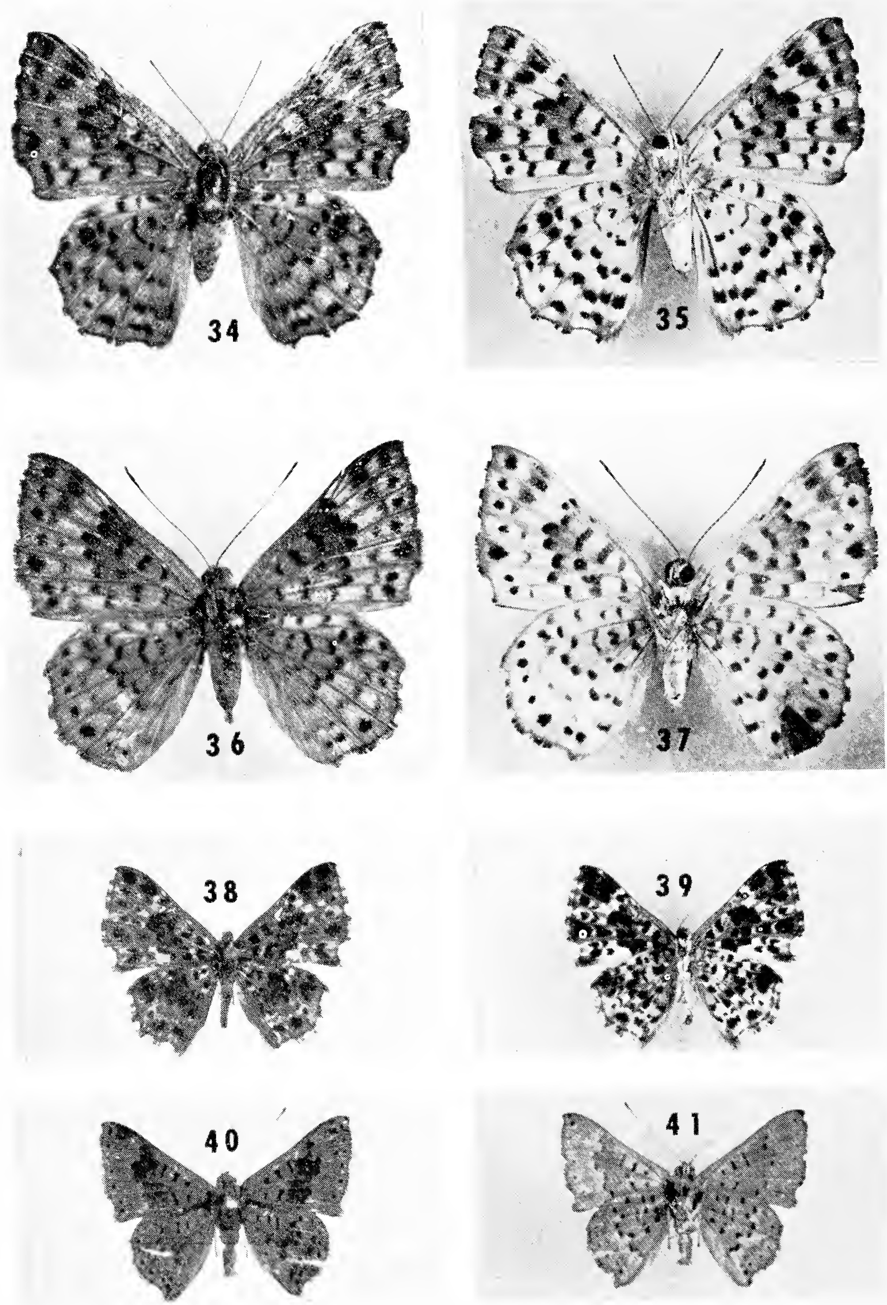
Lasaia moeros kennethi: Stichel 1910. Berliner Ent. Zschr. 55: 48; *ibid.* 1910, Gen. Ins. 112 A: 187; Seitz 1917, Grossschmett. Erde 5: 692 [see note under *m. moeros*]; Stichel 1930, Lep. Cat. 26: 438.

Lasaia merita Godman 1903, Trans. Ent. Soc. London 1903: 541, pl. 22 fig. 9; Mengel 1905, Cat. Eryc.: 109; Stichel 1910, l.c. [both references] and 1930, *l.c.* [in all as syn. of *kennethi*].

Lasaia moeros merita: Seitz 1917, *l.c.*, pl. 135 i.

Lasaia pura Seitz 1917, Grossschmett. Erde 5: pl. 135 h [in text, p.692, erroneously synonymized to *m. moeros*]; Stichel 1930, Lep. Cat. 26: 439 [as syn. of *kennethi*].

Differs from nominate *moeros* in the great reduction of nearly all the fuscous markings. There are no line elements on the hind wing above, and few on the fore wing; on the underside the st


34
35
36
37
38
39
40
41

line is absent on both wings and the pm line of the hind wing is reduced to a few faint, small spots, the area basad not dark-shaded.

This distinctive subspecies appears to replace *moeros* to the south, and possibly ranges to higher elevations. I suspect that it may actually be a distinct species, but unfortunately have seen no specimens.

PERU. Huanuco: Pozuzo[1] (Stichel 1910).

BOLIVIA. Cochabamba: 5 days' travel north of Cochabamba (I estimate that this is about 100 miles north and a little west of Cochabamba, perhaps near the junction of Rio Cotacajes and Rio Santa Elena. Cf. Weeks 1905, Ill. Diurn. Lep. 1: 25 ff.).—La Paz: Coroico, 6500 ft. (TL *merita*).—Not located: Chairo (Godman 1903).

B. *sessilis* group

Wing termen markedly excised between Cu_2 and 2A of fore wing, and with a slight tooth or projection at M_1 of hind wing (both characters found in all the following groups as well); fore wing fringe with white checkering fairly regular, including a distinct white patch between Cu_1 and Cu_2 (this white patch or spot is minute or absent in all following groups); ground color of male upperside darker and less lustrous than in either the *arsis* or *agesilas* groups. Despite the distinctness of this group in external traits there seems to be no comparable group characters in the male genitalia. The frenum is unusually long in *sessilis*, but this is matched in *arsis* (of the *arsis* group); and in the other species, *maria*, the length is conventional. In both species the base of the triangular sclerotized part of the valvae is a little broader than in any other group, but this is of limited diagnostic value. Females are known in both species.

[1]I am inclined to question this locality, far to the north of other records. Nominate *moeros* (*q.v.*) is also recorded from there.

Fig. 34.—*Lasaia agesilas callaina*, n. ssp., ♀ upperside. Paratype. México: San Luis Potosí: Cd. de Valles, 11.vi.1967 (H. A. Freeman).
Fig. 35.—Same specimen, underside.
Fig. 36.—*Lasaia agesilas agesilas* Latreille, ♀ upperside. Panama: Chiriquí, *ex coll.* O. Staudinger, in CM (specimen also figured by Holland 1931, *Butterfly Book* [rev. ed.], pl. 64 fig. 3).
Fig. 37.—Same specimen, underside.
Fig. 38.—*Lasaia oileus* Godman, upperside. British Honduras: Stann Creek Distr.: Middlesex, 125 m, 4.vii.1964 (E. C. Welling).
Fig. 39.—Same specimen, underside.
Fig. 40.—*Lasaia scotina* Stichel, ♂ upperside. Holotype.
Fig. 41.—Same specimen, underside.

This group is confined to Mexico and Guatemala, chiefly at low (*sessilis*) or moderate (*maria*) elevations. Both species have been misdetermined frequently in the past.

2. *Lasaia sessilis* Schaus (Figs. 2, 10, 11)

Lasaia sessilis Schaus 1890, Ent. Americana 6: 18; Godman & Salvin 1901, Biol. Centr.-Amer., Lep. Rhop. 2 (suppl.): 707; Stichel 1910, Gen. Ins. 112 A: 187 [in part].

Lasaia meris var. *sessilis*: Mengel 1905, Cat. Eryc. 109.

This is a rare and extremely local species. Probably because of this rarity, the name *sessilis* has been misapplied commonly to at least two other species (*maria, sula*). Godman & Salvin are the only authors since Schaus to have recognized *sessilis* correctly.

The dark, slightly lustrous bronze-brown upperside of the male, and the uniform gray-brown ground of the underside (both sexes) are exactly as described by Schaus and occur in no other known *Lasaia* except the tiny *scotina*. The male genitalia (fig. 2) differ from those of the related *maria* in several traits. The frenum is much longer than in *maria* (dorsal arm 0.80-0.81 as long as penis in *sessilis*, 0.57-0.59 in *maria*); the scobinate bulla is rounded (flared in *maria*); the lateral angle of the vinculum is approximately a right angle in *sessilis*, obtuse in *maria*.

The species appears to be confined to the foothill region along the eastern Sierra Madre, from central Mexico south to Guatemala.

MEXICO: San Luis Potosí: Cd. Valles, *leg.* H. A. Freeman (CM). Veracruz: Coatepec (TL); Jalapa (AMNH, also Godman & Salvin, l.c.); Fortín [de las Flores], *leg.* B. Mather (CM and coll. B. Mather); Córdoba (CM); Ojo de Agua [= source of Rio Atoyac, nr. Córdoba], 1600 ft. (AMNH). Mexico, no further data (AMNH).

GUATEMALA: Rio Chisoy [Chixoy] (Godman & Salvin, *l.c.*).

3. ***Lasaia maria*** new species

3. a. *Lasaia maria maria* new subspecies (Figs. 3, 12-15)

Lasaia sula: Stichel 1910, Gen. Ins. 112 A: 186, pl. 26 fig. 49; Seitz 1917, Grossschmett. Erde 5: 692; Hoffman 1941, An. Inst. Biol. Mexico 11: 697 (?).

Lasaia sessilis: Seitz 1917, Grossschmett. Erde 5: 692, pl. 142 f.

Additional references may apply to this species, but are too doubtful to list.

Male. Upperside dull steel blue. Fore wing with all line elements typical of the genus, black, thin and linear in disc and base of wing; area between pm line and cell-end bar filled with fuscous; just distad of pm line at costa a few whitish spots; st spot in Cu_2-2A faint or absent; no infuscation in Cu_1-Cu_2 terminal area. Fringe with definite white spot in Cu_1-Cu_2 as large as those costad. Hind wing with costal area ruddy brown

in basal half; all line elements present, black, thin and linear, faint below M_1 + costal border of cell; segment of pm line in Rs-M_1 dislocated only a little distad of those before and after it. Underside of both wings ochreous or ruddy brown, with all line elements present, thin and faint, but those in terminal area reduced almost to absence. Extreme base of fore wing, a band between pm and st lines on both wings, and inner marginal area of hind wing, all gray-blue.

Female. Upperside of both wings ruddy brown or gray-brown, more or less suffused with dull steel blue (fresh specimens may be nearly as blue as the males); all line elements present, fuscous, thin; between pm and st lines a whitish band cut by dark veins, may be present (sometimes on both wings, sometimes on fore wing alone, sometimes almost completely suppressed). Underside as in male, but a little paler and bluish areas are white instead.

Male genitalia (fig. 3). Frenum barely over average length, the dorsal arm being 0.57-0.59 as long as penis; scobinate bulla flared; lateral angle of vinculum sharp and obtuse.

Length of fore wing: males, 13.0-15.0 mm, mean (of 4) 14.4 mm; females, 13.0-15.0 mm, mean (of 3) 14.3 mm. The type series only.

Holotype, male, Ajijic, 5300 ft., Jalisco, Mexico, 20.vii. 1966, *leg.* R. G. Wind.

Paratypes, 4 males and 4 females, same locality and collector, some labelled 5300 or 5400 ft., some with no elevation indicated, dated 2.ix.1965 (♂), 8.viii.1966 (♀), 3.ix.1966 (♂), 4.xii.1966 (2♀)), 7.xii.1966 (♂), 9.xii.1966 (♂), 17.xii.1966 (♀).

Holotype and all paratypes, C. M. Ent. type series no. 645.

Remarks. In addition to the type series I have seen specimens from the following localities:

MEXICO. Jalisco: 7 mi S of La Cumbre de Autlán, 3200 ft., 1966, *leg.* P. Hubbell (2♂, AMNH).—Colima: Colima, 1600 ft., 26.i.1968, *leg.* R. G. Wind, at light (1♀, AME); Comala, 2100 ft., 4-19.v.1967, *leg.* R. G. Wind (1♂ 2♀, CM).—Michoacán: Uruapan, v, *ex coll.* C. C. Hoffman (1♂ AMNH); El Sabino, Uruapan, 15-30.vii.1936, *leg.* H. D. Thomas (1♂ AMNH); Balneario San José Purúa [nr. Zitacuaro], [ca. 4300 ft.], 1.xii.1965, *leg.* B. Mather (series, coll. B. Mather and CM). — Guerrero: no further data, vii.1911, *ex coll.* C. C. Hoffmann (2♂ AMNH). — Oaxaca: Huajuapan [de Leon], ix.1937, *ex coll.* C. C. Hoffmann (1♀ AMNH); Tehuantepec, 16.viii.1964, *leg.* H. A. Freeman (1♀ CM).

GUATEMALA. Rabinal, 3000 ft., vii.1947, *leg.* C. & P. Vaurie (2♂ AMNH).

L. maria has been known a long time, as shown by the two illustrations cited above (both misidentified: by Stichel as *sula*;

by Seitz as *sessilis*). Apparently *maria* has been misdetermined most often as *sula* and, since both species occur in close proximity and sometimes together (as at Comala, Colima), a detailed comparison of the two may be useful.

Both are about the same size, and females of both may have pale postmedian bands (between pm and st lines) above. Males of *sula* are shining blue-green to green above, of *maria* dull steel blue, not shining and rarely greenish (but compare *maria anna* below); males of *sula* have the terminal area in Cu_1-Cu_2 of the fore wing above suffused with fuscous, not so in *maria*; females of *sula* have gray-brown ground above, never bluish, while *maria* females are suffused with dull bluish above, often extensively; on the underside both sexes of *sula* have patches of whitish or pale bluish ground color in the marginal areas (distad of the st line) on both wings, while in *maria* these areas are solid brownish. Males of *maria* have a white spot in the fringe of the fore wing in Cu_1-Cu_2 about as large as those costad; in *s. sula* this spot is absent entirely; in *sula peninsularis* it is present, but a little smaller than those costad.

The closest relative of *maria* appears to be *sessilis*, from which *maria* differs in the steel blue (instead of brown) upperside of the male, and the paler and variegated underside ground color. The genitalia of the two species are quite different (fig. 3, *maria;* fig. 2, *sessilis*); the frenum of *maria* is much shorter (length of dorsal arm 0.57-0.59 length of penis in *maria,* 0.80-0.81 in *sessilis*); the scobinate bulla in *maria* is flared, in *sessilis* round; the ventral segment of the vinculum is somewhat more curved in *maria* than in *sessilis* (where it is unusually straight).

As far as records reveal, nominate *maria* occurs at middle elevations (mostly from 2000 to 6000 ft.) from western central Mexico south to central Guatemala. Hoffmann's (*l.c.*) description of the range of "*sula*" conforms well with the records here given of *maria,* and I therefore believe that he misdetermined this species as *sula.*

It gives me much pleasure to name this handsome and distinctive species in honor of my wife, Dr. Mary Anne Heimerdinger Clench.

3 b. ***Lasaia maria anna,*** new subspecies

Male. Differs from the nominate subspecies in the following ways: the upperside color is distinctly dull greenish blue, rather than steel blue; the subapical costal white spots of the fore wing

are fainter; the upperside black spotting is somewhat reduced; the underside pale band between pm and st lines is more distinct and, on the fore wing, more shining bluish. The adterminal black spots on the underside of both wings are larger and more prominent.

Female. The single female examined is a fresh specimen, larger than any of the examined females of the nominate subspecies (fore wing length 16.0 mm.). The upperside is gray-black, strongly overcast with dull steel blue, and lacking any ruddy or brownish tinge; the whitish band distad of the pm line is moderately indicated on the fore wing, barely so on the hind wing: the adterminal fuscous spots are much larger and darker on both wings. On the underside the ground is more grayish (distinctly less ochreous) than in nominate females and the adterminal spots, as on the upperside, are much larger and darker.

Holotype, male, [Cd.] Victoria, [Tamaulipas], Mexico, 10.vi, C. M. Ent. type series no. 646.

Paratypes, 5 males, all same locality, 10.vi.1941. Three of these bear the collectors' names: [D.B.] Stallings and [J.R.] Turner; all are in the AMNH. 1 female, ca. 26 km SW Tula, ca. 22° 50′ N, 99° 53′ W, 1000 m, Tamaulipas, Mexico, 13.ix.1970 (*leg.* Harald Schreiber and C.J. McCoy, Jr.); in CM.

Remarks. In addition to the type series there is a single male in the AMNH from Jalapa [Veracruz], *leg.* Schaus. This subspecies, apparently confined to central eastern Mexico, seems to be unusually local and uncommon.

C. *arsis* group

The species of this group are distinguished, at least in the males, by the presence of a clear white patch (usually enclosing a black dot) in the middle of the costal area of the hind wing upperside. Males are shining blue-green above, as in the *agesilas* group, but generally with heavier fuscous markings on the fore wing above, and with sharper, more crisp and contrasty, fuscous line elements and mottling below. The male genitalia have the processus superior of the valvae closely encircling the penis, their sclerotized parts a little longer than in other groups; the penis is less curved, and the curve more distad, than in other groups. I have seen no females of any of the species.

So far as available records indicate, this group is entirely confined to South America, extending north only to Panama. Repeated references to members of this group from farther north appear to be based on misidentification.

4. *Lasaia arsis* Staudinger (Figs. 4, 16, 17)

Lasaia arsis Staudinger 1888, Exot. Tagfalter: 257, pl. 91.
Lasaia meris: Staudinger, l.c.; Mengel 1905, Sat. Eryc. : 108.
Lasaia meris arsis: Stichel 1910, Berliner Ent. Zschr. 55: 48; *ibid.* 1910 Gen. Ins. 112 A: 186; Seitz 1917, Grossschmett. Erde 5: 692, pl. 135 g; Stichel 1930, Lep. Cat. 26: 436.

Staudinger named *arsis* on the cited plate, but synonymized it in the accompanying text to *meris*. It is probably for this reason that no syntype series is marked as such in the Staudinger material of the Berlin Museum. As Staudinger observes, at that time two distinct species [he refers to *arsis*, which he called *meris*, and *agesilas*, which he called *narses*] were widely confused in collections under the name *meris*. He was first made aware of this through the specimens and field observations of Dr. Hahnel (see under *agesilas*), so it is most appropriate that the Hahnel specimens of both forms be considered syntypic respectively. Staudinger probably exchanged or sold many of these, but under *arsis* two such specimens survive. Either could well have been the specimen illustrated on plate 91, but one seems to fit a little better than the other. This one I here designate as lectotype, and I have so labelled it. The other I have labelled as paratype.

Lectotype of *Lasaia arsis* Staudinger 1888: ♂, bearing a printed label (black letterpress), "Manicoré / Hhl." and a second printed label (black letterpress), "Coll. / Staudinger." To these I have added a penned label reading "Lectotype ♂ / Lasaia arsis / Staudinger 1888 / design. H. Clench / Aug. 1970." Length of fore wing 15.5 mm.

Paratype of *L. arsis*: ♂, bearing a penned label, "Yurimaguas / Hhl. 83" and a printed label, "Coll. / Staudinger."

Both specimens are in the Museum für Naturkunde des Humboldt-Universität, Berlin.

Differs from *pesudomeris* (♂) in its larger size (fore wing length 16-17 mm compared to ca. 13-14 mm in *pseudomeris*) and heavier spotting, particularly on the hind wing, which is liberally spotted below M_1 + costal border of cell (almost immaculate in *pseudomeris*). From *meris* it differs, so far as I can tell, chiefly in its larger size (*meris* is about the size of *pseudomeris*). Staudinger's figure is excellent and the specimens I have examined agree well with it. The male genitalia are quite distinct from those of *pseudomeris* (see comparison under that species). They strikingly resemble, particularly in the frenum, the genitalia of *sessilis*.

It is possible that *arsis* is a subspecies of *meris*, as Stichel

thought, but without specimens of *meris* I cannot tell, and material of *arsis* at hand does not indicate any significant geographic variation.

Material seen implies that *arsis* occupies a disjunct range. One area includes the Andes, apparently chiefly their eastern foothills, from Venezuela south to Bolivia. The second area comprises the lower Amazon River. In support of this disjunction is the fact that there are no specimens in Carnegie Museum from Sao Paulo de Olivença or localities on the Rio Purús, although we have large collections from these places. Specimens have been seen from these localities:

VENEZUELA. "Mts. of Merida" (CM).

COLUMBIA. Cundinamarca: Bogotá (AME). — Boyaca: Muzo (AME).

ECUADOR. Pastaza: Rio Sarayuco, 7. viii. 1963, *leg.* Lefevre (CM).

PERU. Loreto: San Roque, W. Iquitos (AME); Balsapuerto, [nr.] Rio Paranapura, *leg.* A.S. Pinkus (AMNH).—Huanuco: Tingo Maria, vi.1947, *leg.* Church (AMNH).—Pasco: Rio Palcazu, Chuchuras (AME).—Junin: La Merced, vii.1930, *ex coll.* W.P. Comstock (AMNH).—Not located: "N.E. Peru," *leg.* Bassler (AMNH); Oroya (AME).

BOLIVIA. Santa Cruz: Rio Yapacani, 600 m, ii, ii, ix; Buena Vista, 400 m, v, all *leg.* J. Steinbach (CM).

BRASIL. Pará: Pará [= Belém]; Obidos; both *ex coll.* ANSP (CM).

5. *Lasaia meris* Stoll

Papilio meris Stoll [1781], Pap. Exot. 4: 146, 250, pl: 336 figs. B, C [usually credited to Cramer, but see F. M. Brown 1941, Ann. Ent. Soc. America 34: 128-129.]

Lasaia m. meris: Stichel 1910, Gen. Ins. 112 A: 186 (in part); Seitz 1917, Grossschmett. Erde 5: 682, pl 135 g [in part, but the figure appears to represent true *meris*].

Lasaia meris: Kaye 1904, Trans. Ent. Soc. London 1904: 187; Mengel 1905, Cat. Eryc.: 108.

Lasaia meris is both the first known *Lasaia* and the type of the genus, but it remains unknown to me. Were it not for the figures of Stoll and Seitz I should be inclined to believe that *meris* represented some one of the other known species in the genus. These figures, however, agree with each other and depict a perfectly credible entity: a form as small as *pseudomeris* but at least as heavily marked above as *arsis*. The stated type locality of *meris* is Suriname, and there is no reason to question it. For some reason there are almost no records of *Lasaia* from the Guianas region (*a. agesilas* and *oileus* only), and it would be reasonable to expect a form endemic in this region. Kaye (1904) has recorded a *Lasaia* from Trinidad, at the western end of the Guiana region, under the name *meris*. I have not seen his material, but he could well be right.

It is possible that *meris* may eventually be found conspecific (subspecies) with either *arsis* or *pseudomeris*.

6. ***Lasaia pseudomeris*** new subspecies (Figs. 5, 18, 19)
Lasaia meris: of authors, in part.

Male. Upperside shining blue-green. Fore wing with the usual fuscous marks, but the pm and st lines generally faint below Cu_2. Just distad of the pm line on the costa are two or three small white spots. The fuscous adt spot in Cu_1-Cu_2 is conspicuously infuscate to termen (as in all members of this and the *agesilas* groups). Hind wing with costal white patch, with or without an enclosed black dot; all fuscous marks below M_1 + costal border of cell are exceedingly faint (mostly in cell) or absent entirely, except for the adt series. *Underside*: both wings brown, with all fuscous marks present. Fore wing a little paler in basal fourth of wing; between pm and st lines paler, whitish costad, filled with pale blue-gray posteriorly. Distad of st row whitish from M_3 to tornus except for infuscation in Cu_1-Cu_2 from adt spot to termen. Hind wing with basal third white; between pm and st lines brown costad of M_2, bluish from there posteriorly. St and adt fuscous spots enlarged at tornus. Fringe of fore wing without white dot in Cu_1-Cu_2; of hind wing almost entirely white, the fuscous at the vein-ends hardly thicker than the veins and sometimes absent entirely.

Male genitalia. Lateral angle of vinculum about a right angle, as in *arsis*; frenum of about average length (dorsal arm 0.52-0.56 as long as penis), not long as in *arsis* (dorsal arm 0.82 as long as penis); the scobinate bulla is flared (rounded in *arsis*).

Length of fore wing: males, 13.5-14.5 mm, mean (of 4), 14.1 mm. (the type series only).

Holotype, male, Chiquitos [= San José de Chiquitos, Santa Cruz], Bolivia, 300 m, iii.1918, *leg.* J. Steinbach, *ex coll.* W.J. Holland.

Paratypes, three males, all Santa Cruz, Bolivia, same collector, as follows: 1, same data as holotype; 1, Santa Cruz de la Sierra, 450 m, no date, C.M. Acc. 5570; 1, Rio Surutu, 350 m, iii.1915, CM. Acc. 5570.

Holotype and paratypes, C.M. Ent. type series no. 647.

Remarks. In addition to the type series I have seen specimens from the following localities:

PANAMA. Chiriquí, *ex coll.* Staulinger [sent as *meris*], *ex coll.* ANSP (1 ♂ CM).

VENEZUELA. Amazonas: Mt. Duida, 14.xi.1928, *leg.* Tate (1 ♂ AMNH).

COLOMBIA. Cundinamarca: Bogotá (1 ♂ AME).—Not located: "Colombia" (AMNH).

PERU. Amazonas: Rio Santiago, *leg.* Bassler (1 ♂ AMNH).—San Martín: Rio Moropa, Moyobamba region, *leg.* Bassler (1 ♂ AMNH).—

Junín: Satipo, ix.1947, *leg.* Paprzycki (1 ♂ CM), and *ex coll.* Le Moult (1 ♂ AME).

BRASIL. Amazonas: Teffé, Rio Solimoes, *ex coll.* Le Moult (1 ♂ AME).— Pará: Obidos (AME); Igarapi-Assu [= Igarape Acú], xii.1911-ii.1912. *leg.* H.S. Parish (1 ♂ AMNH).—Parana: no further data (AME).

This species is about the same size as *meris* and much smaller than *arsis*. It differs from both in the almost complete suppression of fuscous marks on the hind wing upperside posterior to M_1 + costal border of cell. In addition, it differs from *arsis* in the much reduced black fringe spots (which are several times as wide as the veins in *arsis*, those at Cu_1 and Cu_2 being each a little more than half as wide as the white between them). The male genitalia of *arsis* and *pseudomeris* are, as noted above, quite different.

The two males from Satipo, Peru, have all the pale areas below nearly pure white. In the other specimens the several pale areas, particularly that between the pm and st lines on the fore wing, are largely filled with pale dusty bluish.

D. *agesilas* group

This is the "residue" of forms not distinguished by special external characters. Its members are of average size (not small, as in the *oileus* group); with typical dentate margins (not relatively smooth-margined as in the *moeros* group); the upperside of the males is shining blue-green (not dull blue or bronze-brown as in the *sessilis* and *oileus* groups); and there is no costal white patch on the hind wing above (as in males, at least, of the *arsis* group). In the male genitalia the species all have a distinctively short frenum (dorsal arm/penis length 0.35-0.44 in *sula*; 0.38-0.44 in *agesilas*; 0.46 in *aerugo*). In addition the ventral arm of the frenum is thicker in lateral view and appears to be more complexly structured. Females have been seen of the two common species.

Three species are recognised, one (*aerugo*) known from but a single specimen. The other two (*sula, agesilas*) are similarly patterned and colored, both polytypic, both much misdetermined in past literature. These two are closely related, but they are genitalically distinct and broadly sympatric.

7. *Lasaia sula* Staudinger

Extremely similar to *agesilas*, but smaller (male fore wing length about 14 mm, compared with about 16-17 mm in *agesilas*), inclined to be more greenish above, the spotting less strong, and rarely if ever with the space between cell-end bar and pm line of fore wing above filled with fuscous. On the underside the basal area of the fore wing is whitish (pale brown in *age-*

silas), and all the spotting is thinner and fainter. On the fore wing a pale patch—often whitish—is usually present in the distal end of the cell (chiefly in *sula peninsularis*), almost never in *agesilas*. The male genitalia (fig. 7 of *sula peninsularis*; the genitalia of *s. sula* have also been examined and are similar) differ from those of *agesilas* in the flared scobinate bulla (rounded in *agesilas*), in the acute, sharp lateral angle of the vinculum and in the more curved ventral segment of the vinculum.

This species occupies a more or less continuous range from Texas to Honduras. Nominate *sula* occurs from Nayarít south along the west coast of Mexico and across Guatemala to northwestern Honduras. The new subspecies *peninsularis* appears to be confined to the easter coastal regions, from Texas south to the Yucatán Peninsula of Mexico.

7 a. ***Lasaia sula peninsularis***, new subspecies (Figs. 7, 20-23)

Lasaia sessilis: of authors, at least in part, including: Hoffmann 1941, An. Inst. Biol. (México) 11: 697 [identity not certain, but his range description fits this species]; Klots 1951, Field Guide to Butterflies: 125, pl. 18 fig. 4 [figure = *s. sula*]; Ehrlich 1961, *in* Ehrlich & Ehrlich, *How to Know the Butterflies*: 246, fig. 487.

Differs from *s. sula* as follows: male upperside, no differences except fringe (see below); underside with no ochreous on either wing; basal area of fore wing white instead of ochreous; band between pm and st lines iridescent blue on both wings; st row a series of chevrons, concave outward and usually connected at the veins (in *s. sula* a series of dots or short bars, not connected below M_3 on either wing). Fringe usually with a small white internervural dot in Cu_1-Cu_2 of fore wing, visible both above and below (in nominate *sula* the fringe is solid black in this interspace). Female differs only in the chevron-shaped elements of the st line on the underside (showing also, but less clearly, on the upperside). The white Cu_1-Cu_2 fringe dot appears to be absent in this sex as in females of the nominate subspecies.

Length of fore wing: males, 12.5-13.5 mm; mean (of 2) 13.0 mm; female, 14.0 mm.

Holotype: male, Pisté, Yucatán, México, vii.1952, *leg.* E.C. Welling.

Paratypes: 4♂, as holotype; 1♀, Chichén Itzá, Yucatán, México, 20.vi.1954, *leg.* E.C. Welling.

Holotype and paratypes, C.M. Ent. type series no. 648.

Remarks. In addition to the type series, material has been examined or reported from the following localities:

TEXAS. Pharr (Klots 1951, but not figure; Ehrlich 1961, incl. figure; also AMNH, CM); Brownsville (AMNH; CM); McAllen (AMNH).

MEXICO. Tamaulipas: Arroyo del Meco, 1320 ft., 28.iv.1941. *leg.*

J.&R. Potts (AMNH).—San Luis Potosí: El Salto, 360 m, *leg.* L. & J. Miller (AME); El Benito[2] Valles, 150 ft., 30.iv.1941, *leg.* J.&R. Potts (AMNH).—Veracruz: 1-2 mi W Nanchital, *leg.* L. & J. Miller (AME); 2 mi SE Coatzacoalcos, 18.i.1966 *leg.* H. Clench & L. Miller (CM); Presidio, viii.1954, *leg.* T. Escalante, *ex coll.* C. C. Hoffmann (AMNH).

The subspecies appears to be confined to the eastern lowlands and foothills, from southern Texas south to the Yucatán Peninsula.

7. b. *Lasaia sula sula* Staudinger (figs. 24, 25)

Lasaia narses var. *sula* Staudinger 1888, Exot. Tagfalter: 257 (TL: San Pedro Sula, Honduras).
Lasaia sessilis: of authors, at least in part.

Other references are omitted, since the name *sula* has been almost universally misapplied in earlier works.

The Staudinger type series consists of three males all from Honduras, *leg.* "W" or "Wittk." [Wittkügel]. From these I have selected a lectotype as follows:

Lectotype of *Lasaia narses* var. *sula* Staudinger 1888: ♂ with penned label, "Honduras / 87 Wittk."; a printed label, black letterpress on lavender-pink paper, "Origin."; and a printed label, black letterpress, "Coll. / Staudinger." To these I have added a label, "Lectotype ♂ / Lasaia narses / var. sula / Staudinger 1888 / design. H. Clench / Aug. 1970." Length of fore wing 14.0 mm.

Paratypes: 2 ♂ ♂, each labelled in pen, "Hond. / W." and, as above, "Origin." and "Coll. / Staudinger". One bears in addition a black-line bordered white label with the penned [Stichel's hand] "sula / Stgr. / (Stich.)" and a penned "var. Sula / Stgr." To each of these I have added a paratype label.

This subspecies differs from *sula peninsularis* as noted in the description of the latter. The material of nominate *sula* I have examined comes from the following localities:

MEXICO. Nayarít: Compostela, 10.viii.1932 (1 ♂ AMNH fig'd in Klots 1951).—Colima: Colima, 1600 ft., *leg.* R.G. Wind (series, mostly ♂ ♂, CM, AME); La Salada, 1000 ft., *leg.* R.G. Wind (AME); Comala, 2100 ft., *leg.* R.G. Wind (series; CM).—Chiapas: Cd. Cuauhtemoc, 700 m, *leg.* L.&J. Miller (AME).

HONDURAS. no further data (1 ♂, CM). Also type locality, San Pedro Sula (Staudinger 1888, and above).

8. ***Lasaia aerugo***, new species (Figs. 26, 27)

Similar in size and pattern to *sula*, and compared (♂ only) with it as follows: upperside with ground bluer; space between cell-end bar and pm line somewhat tinged with fuscous (not so in *sula*); pm line of hind wing absent below M_1 (faint but present in *sula*); fuscous fringe spots at Cu_1 and Cu_2 each about as wide as white fringe between them (much smaller than the

[2] El Bañito, according to F. M. Brown 1943, J. New York Ent. Soc. 51: 162.

included white in *sula*). Underside with st line more basad (adt spots about midway between st line and termen); hind wing ground distad of st line all white (in *sula* infuscated costad of M_2 and posterior to 2A). Underside spotting larger but crisper; no trace of the bluish shading between pm and st lines found in *sula*.

Male genitalia. Vinculum laterally not so abruptly angled as in *sula*; the scobinate bulla of the frenum has fine hairlike teeth proximally, giving way abruptly to coarse teeth posteriorly. In *sula* the proximal teeth are a little larger and not so hair-like, the posterior teeth not so coarse, and the transition is gradual. Unfortunately the male genitalia of the single available specimen of *aerugo* were mounted in opened ventral view and this has distorted the scobinate bulla so that I cannot tell if it is rounded or flared.

Fore wing length 14 mm.

Holotype, male, Llangua, Rio Llangua, Dept. Cajamarca, Peru, 1500-2000 m, 14.vi.1936 (*leg.* F. Woytkowski), C. M. Acc. 11045. C. M. Ent. type series no. 649.

Remarks. A distinctive species, and apparently either rare or extremely local. The name *aerugo* is latin for *verdigris.*

9. *Lasaia agesilas* Latreille

Differentiated from *sula* above. From the localities I suspect that *agesilas* may be a species of mesic to humid forest, while *sula* appears to be associated with relatively more arid, more open country (low or open forest and scrub).

9. a. ***Lasaia agesilas esmeralda,*** new subspecies (Figs. 32, 33)

Lasaia agesilas agesilas: Stichel 1910, Berlin Ent. Zschr. 55: 48; *ibid.* 1910, Gen. Ins. 112. A: 187; Seitz 1917, Grossschmett. Erde 5: 692.

Differs from nominate *agesilas* only in the green (rather than blue-green) ground color of males above, and in the reduced upperside fuscous spotting, the spots smaller (especially in basal area of the fore wing) and commonly nearly lacking on the hind wing below M_1 + costal border of cell. It resembles *a. callaina* of Middle America in the reduced spotting but differs from that subspecies in the green color and in the virtual absence of the blue gloss on the underside.

Holotype, male, Villa Rica [= Villarrica], Paraguay, no date, *leg.* P. Jorgensen, *ex coll.* ANSP.

Paratypes: 2 ♂ same locality and collector, 11.xi and 11.xii. 1921, *ex coll.* ANSP; 1 ♂ same locality, collector unknown; 2 ♂ Paso Yobay, Paraguay, Nov. and Dec. 51. "rec. G.S."; 1 ♂ Paso Yobay, Villarica, Paraguay, xi. 51, *leg.* F.M. Schade.

Holotype and first two paratypes, C.M. Ent. type series no.

650; the next paratype in AMNH; last three paratypes, AME (Acc. 1969-70).

Remarks. In addition to the type series I have seen material from the following localities:

BRASIL. Sta. Catharina: Nova Teutonia (27°11′ S, 52°23′ W), 26.xii. 1939, *leg.* F. Plaumann (CM); Rio Lacisz, 1934, *leg.* Klug (series, AMNH). —Sao Paulo: Forest of Rio Tieté, nr. Itapura, 29.ix.1908, *leg.* Haseman (CM).—Paraná: Iguassu, 28.ix.1921, 20.xii.1921, 21.i.1922 (AME).

For some reason Stichel (1910, both references) assumed that the type locality of nominate *agesilas* was in southern Brasil. He accordingly called this subspecies nominate *agesilas,* and applied the name *narses* to the subspecies of more northern South America and Central America (*a. agesilas* and *a. callaina* here).

9. b. *Lasaia agesilas agesilas* Latreille (Figs. 30, 31, 36, 37)

Erycina agesilas Latreille 1809, *in* Humboldt & Bonpland, Voyage, Rec. obs. Zool. et Anat. Comp. 1: 396, [pl. 25 figs. 7, 8]; *ibid;* 1827, *op. cit.* (2nd edition): 251.

Lasaia meris: Godman & Salvin 1886, Biol. Centr.-Amer. 1: 455 (in part); and of other authors, in part.

Lasaia narses Staudinger 1888, Exot. Tagfalter: 257; Holland 1931, Butterfly Book (rev. edition): 216 [refers to *a. callaina*], pl. 64 figs. 2, 3 [figs. = *a. agesilas* from Chiriqui, Panama, *ex* Staudinger, received as *narses*].

Lasaia agesilas narses: Stichel 1910, Berlin Ent. Zschr. 55: 48; *ibid.* 1910, Gen. Ins. 112 A: 187; Seitz 1917, Grossschmett. Erde 5: 692, pl. 135 h. These authors all included *callaina* in their concept of "*narses.*"

The type locality of *agesilas* is "les bords de la rivière des Amazones, dans la province de Jaen de Bracamorros." According to Mr. D.S. Fletcher of the British Museum (personal communication) descriptions of other species in the same work refer to "Jaen de Bracamorros, au Pérou." An old map (undated) in the General Library (British Museum) shows a province of Jaen with the town Jaen de Bracamorros. This town appears on modern maps as Jaen, on the middle Rio Marañon, in Cajamarca, northern Peru.

The colored illustration of Latreille (it is uncertain whether these plates were issued with the first or the second edition of the text) are somewhat fanciful, but they and the description fit the present species better than any other. In particular, the large size (Latreille gives 38 mm expanse, which corresponds roughly to a fore wing length of 19 mm, about the upper limit for the species), the brownish disc and base ground color below with paler terminal areas, all are characteristic of the present species.

Staudinger (*l.c.*) in describing *narses* and differentiating it from *meris* said (transl.): "Under the name *meris* 2 species have

heretofore been confused, both of which were taken together by Dr. Hahnel on the Amazon, and which he considered as 2 species certainly distinct from one another, and this is also my opinion." For this reason I consider the Hahnel material of both *arsis* Stgr. and *narses* Stgr. to be the only appropriate material from which to select lectotypes. Under *arsis* two such specimens are still present and both are labelled "Origin.," which I take to indicate syntypic status. One of these I here designate as lectotype, the other as a paratype:

Lectotype of *Lasaia narses* Staudinger 1888: ♂, with the following labels: penned, "Pebas / Hhl."; penned [Stichel's hand], "Lasaia meris / (Stich.)"; letterpress, black on lavender-pink paper, "Origin."; penned, in blue, "narses Stgr." To these I have added a label, penned, reading "Lectotype ♂ / Lasaia narses / Staudinger 1888 / design. H. Clench / Aug. 1970." Length of fore wing 18.0 mm.

Paratype of *L. narses*: ♂, labelled in pen, "Maues / Hhl."; letterpress (as above), "Origin."; pen, "narses Stgr." I have added a paratype label.

The lectotype and paratype differ from nearly all the Bolivian material I have seen (listed below) in the much darker postmedian area, between pm line and cell-end bar, on the fore wing upperside. The paratype has the hind wing spotting exceptionally dark and extensive; the holotype is more normal in this respect.

Staudinger's concept of *narses* also included the subspecies *callaina*, described below. He lists Honduras among the localities for *narses*, and in the Staudinger collection, according to Dr. Hannemann, are found syntypes of *narses* from: Rio San Juan, Colombia (*leg.* "Tr." [= Trötsch]); Chiriqui (collector unknown, probably either Trötsch or Ribbe); and 3 ♂ all from Honduras [probably vic. San Pedro Sula] (*leg.* "Wittk." [= Wittkügel] 1888).

Nominate *agesilas* is widely distributed over northern and central South America, except for southeastern Brasil and Paraguay (where the subspecies *esmeralda* occurs), and extends north into southern Costa Rica. In northern Costa Rica and northward it is abruptly replaced by *callaina*. The following localities for nominate *agesilas* are known to me:

COSTA RICA. Puntarenas: 4-11 mi N Palmar Sur, Rio Terralba, *leg.* H. Real (CM).

PANAMA. Chiriqui, (CM, *ex coll.* Staudinger [sent to Holland as *narses*], figured as *narses* by Holland 1931, Butterfly Book (rev. ed.): pl. 64 figs. 2, 3); Canal Zone (AMNH).

VENEZUELA. Amazonas: Mt. Duida (AMNH).—Not located: Metaban, *ex coll.* F. Johnson (AMNH).

TRINIDAD. no further data (AME).

COLOMBIA. Magdalena: Bonda, 250 ft., *leg.* H.H. Smith (CM).—Cundinamarca: Bogotá (AME).—Boyaca: Muzo, *ex coll.* Le Moult (AME); La Lechera, 850 m, Rio Opon, N Tunja; 15.ii.1946, *leg.* L. Richter (AMNH).—Antioquia: Casabe, across Rio Magdalena from Barranca Bermeja; 1-18.iv.1958, *leg.* Mrs. D.S. Bos (AMNH).—Not located: Choachi (CM, AMNH); La Vega (AMNH); Las Mesitas (CM); "New Granada" (CM).

ECUADOR. Manabí: Palmar, 200 m, 13.iv.1941, *leg.* D. B. Laddy (AMNH).—El Oro: Piñas, *ex coll.* F.M. Brown (AMNH).—Zamora Chinchipe: Zamora, *ex coll.* F.M. Brown (AMNH).—Oriente: Rio Pastaza, xii.1968, *leg.* R. de Lafebre (AME).—Pichincha: Rio Toachi, vi.1969, *leg.* R. de Lafebre (AME).

PERU. Loreto: lower Rio Tapiche, *leg.* Bassler; Balsapuerto, [nr.] Rio Paranapura, *leg.* A.S. Pinkus; middle Rio Ucayali, *leg.* Bassler; (all AMNH); San Roque, W of Iquitos, *ex coll.* Le Moult (AME).—Amazonas: Rio Santiago, *leg.* Bassler (AMNH).—Cajamarca: Jaen (TL *agesilas*).—Pasco: Chuchuras, Rio Palcazu, *ex coll.* Le Moult (AME).—La Libertad (?): upper Rio Marañon, *leg.* Bassler (AMNH).—Huánuco: Rio Pichis, 300 m. (AME); Rio Pachitea, *leg.* Bassler (AMNH).—Junín: Chanchamayo, *leg.* Watkins; Satipo, *ex coll.* Le Moult (both AME); Rio Perene, *leg.* A.S. Pinkus (AMNH).—Cuzco: Grande Pintabamba, 3400 ft., Quillabamba, *leg.* J.D. Pallister (AMNH).—Not located: Achinamiza, *leg.* Bassler (AMNH).

BOLIVIA. Santa Cruz: Portachuelo, Rio Palmatillas; Santa Cruz de la Sierra, 450 m; Rio Yapacani, 600 m; Rio Surutu, 350 m; Prov. del Sara, 450 m; Buena Vista, 400 m; [San José de] Chiquitos, 300 m; Incavaca, Chiquitos, 300 m; all *leg.* J. Steinbach (CM).

BRITISH GUIANA. no further data (AME).—Waramadong [not located] (AMNH).

BRASIL. Amazonas: Rio Negro, *leg.* Bassler (AMNH); Sao Paulo de Olivenca, *leg.* S. Klages (CM).—Pará: Obidos (AMNH).

9. c. ***Lasaia agesilas callaina*, new subspecies** (Figs. 6, 28, 29, 34, 35)

Lasaia narses Staudinger 1888, Exot. Tagfalter: 257 (in part); Holland 1931, Butterfly Book (rev. ed.): 216 (but not pl. 64 figs. 2, 3, which represent *a. agesilas*); Ehrlich 1961, *in* Ehrich & Ehrlich, *How to Know the Butterflies*: 246 (but not Fig. 487, which represents *a. agesilas*).

Lasaia agesilas narses: of authors, in part.

Lasaia sessilis: Seitz 1917, Grossschmett. Erde 5: 692, pl. 135 i (misdetermination on plate, corrected in text; the figure, however, represents *a. callaina*).

? *Lasaia meris*: Hoffmann 1941, An. Inst. Biol. Mexico 11: 697.

Differences from the nominate subspecies are slight but constant, and apparently confined to the male. They consist of a reduction in size of the pm spots of both wings below M_3, and of the spots basad of this series in Cu_2-2A on the fore wing. On the hind wing the spots are virtually or entirely absent below M_3. The underside (both wings) is often more heavily glossed with blue.

Holotype, male, Cd. Valles, San Luis Potosí, México, 28.vi. 1968, *leg.* H.A. Freeman, C.M. Acc. 23054.

Paratypes, same locality and collector, 3 males, 9.vi.1966, 9.vi.1967, 29.vi.1968; 1 female, 11.vi.1967.

Holotype and 4 paratypes, C.M. Ent. type series no. 651.

Remarks. Widespread, but not very common, from central Mexico (both coasts) south to northern Costa Rica (replaced in southern Costa Rica by the nominate subspecies). Other localities for *callaina* are:

MEXICO. Nayarít: Compostela, *leg.* A.S. Pinkus (series, AMNH).—Jalisco: Tenacatita, 22.ix.1939, *ex coll.* F.H. Rindge (AMNH).—Colima: Colima, 6000 ft. (AMNH).—Guerrero: Agua del Obispo, *ex coll.* C. C. Hoffmann (AMNH).—San Luis Potosí: El Benito[3], Valles, 150 ft. 30.iv. 1941; El Sol, Tamazunchale, 400 ft., 30.iv.1941; Arroyo del Calabazas, 250 ft., 30.iv.1941 (all *leg.* J. & R. Potts, AMNH).—Veracruz: Presidio, *ex coll.* C. C. Hoffmann; Misantla, *leg.* Gugelman, *ex coll.* C. C. Hoffmann; Rio Blanco, 2200 ft., 10.vi.1941, *leg.* J. & R. Potts (all AMNH).—Oaxaca: Tuxtepec, *leg.* A. Diaz F. (AME); Pto. Eligio, Mpio. Comaltepec, 700 m, viii.1962, *leg.* E. C. Welling; Soyolapan El Bajo, 200 m, Mpio. Comaltepec, 1.x.1961, *leg.* E. C. Welling; (both AMNH).—Tabasco: Tepescuintle, 650 ft., Mpio. Tenosique, 20.x.1962, *leg.* E. C. Welling (AMNH); 2-3 mi E La Venta, 31.i.1969, *leg.* J. & L. Miller (AME).—Yucatán: Chichén Itzá, *leg.* E. C. Welling (CM).—Quintana Roo: X-Can, *leg.* E. C. Welling (CM).—Chiapas: La Granja; Pueblo Nuevo; Tapachula (all *ex coll.* C. C. Hoffmann, AMNH); Paraiso *leg.* R. Wind (AME).

GUATEMALA. Escuintla, *leg.* W. Schaus (CM); Rio Polochic, Vera Paz (AMNH).

EL SALVADOR. Los Chorros, Santa Tecla, 28.vii.1963, *leg.* M. Serrano (AME).

HONDURAS. no further data (CM).

COSTA RICA. Guápiles, *leg.* W. Schaus (CM).

I have been unable to find any authentic records of this species from Texas, although recorded from there by Holland (1931) and Ehrlich (1961), and consider its occurrence there to be extremely doubtful. The break between this subspecies and nominate *agesilas* appears to be the central cordillera of Costa Rica. North of these mountains (Guápiles) occurs the Middle American *callaina*; south of them (near Palmar Sur) is found nominate *agesilas*.

The name *callaina* is latin for *turquoise colored.*

E. *oileus* group

Agrees in wing shape and style of pattern with the preceding two groups, but differs from them, and from all other *Lasaia,* in its extremely small size (fore wing length 10-11 mm), in the brown coloration of the male upperside, and especially in the metallic streaks on the distal ends of the veins above in both sexes. The underside pattern of *oileus* is variegated fuscous on whitish, very similar to that of the *meris* group, while that of *scotina* is dark brown dots on a nearly uniform tan ground,

[3] See footnote 2, p.

reminiscent of *sessilis.* I have not examined the male genitalia. The female of *oileus* closely resembles the male, but has slightly more rounded wings, slightly paler, more brownish ground color, and the underside fuscous markings are a little browner.

10. *Lasaia oileus* Godman (Figs. 38, 39)

Lasaia oileus Godman 1903, Trans. Ent. Soc. London 1903: 541, pl. 22 figs. 11; Mengel 1905, Cat. Eryc.: 109; Stichel 1910, Gen. Ins. 112 A: 187; Kaye 1914, Trans. Ent. Soc. London 1914: 563; Seitz 1917, Grossschmett. Erde 5: 693, pl. 135 h; Stichel 1931, Lepid. Cat. 26 (pars 40): 439.

This is a wide ranging species, but it seems to be scarce everywhere. The British Honduras record given below is a major extension of the known range. Known localities for *oileus* are as follows:

BRITISH HONDURAS. Middlesex, 125 m, Stann Cr. District, 4.viii.1964, *leg.* E. C. Welling (1 ♀, CM).

PANAMA. Chiriqui (Stichel 1910).

TRINIDAD. St. Anne's Valley (Kaye 1914); Cascade, 25.iv.1920, *leg.* P. Rodriguez, *ex coll.* W. J. Kaye (1 ♂, AME).

FRENCH GUIANA. Cayenne (Godman 1903). Godman questions this locality, but he does not explain why. If it was only because it is so far from Paraguay, whence his types came, then it should be reconsidered. In the light of our present knowledge of the distribution of this species French Guiana is not unreasonable.

PERU. Amazonas: Rio Santiago, 10.xi.1924, *leg.* Bassler (1 ♀, AMNH).—Cuzco: Marcapata (Stichel 1910).

BRASIL. Para: Igarapi-Assu [= Igarape Acú], xii.1911 - ii.1912, *leg.* H. S. Parish (1 ♂, AMNH).—Sao Paulo: "Indiana" [? = Jundiahy] (AME).

PARAGUAY. no further data (TL *oileus*).

11. *Lasaia scotina* Stichel (Figs. 40, 41)

Lasaia scotina Stichel 1910, Gen. Ins. 112 A: 188 (footnote); *ibid.* 1931, Lepid. Cat. 26 (pars 40): 439; Zikán 1952, Dusenia 3: 44, figs. (♀ described) [not seen].

Stichel gives not one word of comparison between his *scotina* and *oileus,* and his rather brief description of it is enough like *oileus* that I could find no reason to believe it distinct. Thanks to Dr. Hannemann I have been able to examine the type of *scotina.* It is unquestionably distinct from *oileus,* but clearly related. A comparison of the two follows (males only):

On the upperside *scotina* is various shades of chocolate brown, while *oileus* tends to be blackish brown. The white fringe areas are large and conspicuous in *oileus,* minute and inconspicuous in *scotina;* the white fringe in M_1-M_2 of the fore wing of *oileus* is absent (brown) in *scotina,* that in M_3-Cu_1 is large in *oileus,* minute in *scotina,* that in Cu_2-2A is large in *oileus,* small and clouded in *scotina.* On the hind wing *oileus*

has prominent broad white fringe in nearly all interspaces (the black fringe reduced in some instances solely to the vein-ends), while *scotina* has nearly uniform brown fringe with a few white scales only, in interspaces M_3-Cu_1 and Cu_2-2A. In *oileus* there is a prominent subhyaline white spot on the fore wing costa just beyond the pm line, wanting completely in *scotina*. The metallic streaks on the vein-ends are much more prominent in *oileus* than in *scotina*, but they appear much more neat and regular in the latter.

On the underside the pattern of *oileus* is dominantly a series of coarse fuscous blotches on a bluish white ground; in *scotina* the ground is nearly uniform tan, with the line elements as small dark brown dots and bars.

Stichel's holotype of *scotina* is the only specimen I have seen. It has these labels: penned, "R.G.d. / S." [Rio Grande do Sul]; black letterpress on orange-red card, "Type"; penned (Stichel's hand) on a black bordered white label, "scotina/Stich." Fore wing length 10.5 mm (given as 11 mm by Stichel).

Journal of Research on the Lepidoptera 10(2):181-184, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

THE RELATIONSHIP BETWEEN MIGRATION AND DIAPAUSE DURING PHYLOGENY AND ONTOGENY OF SOME LEPIDOPTERA

IVO NOVÁK and KAREL SPITZER

Centr. Res. Institute of Plant Production, Praha-Ruzyne and Univ. College of Agriculture, VSZ, Ceske Budejovice, Czechoslovakia

THERE ARE SEVERAL OPINIONS in the recent literature (Cayrol, 1965; Johnson, 1969 etc.) attempting to explain insect migration as an important ecological feature. It is concluded that migration is a phenomenon aiding the insect in escaping from temporarily unfavorable vital conditions: cold winters or hot, dry summers with the lack of food. The ecological importance of migration and especially its selective value are analogous to the phenomenon of diapause; during phylogeny, migration appeared as one of two possible methods of escape, or resistance, diapause being the other. Diapause or migration or both as escape mechanisms were fixed by natural selection under particular ecological conditions.

In recent papers, the relationship between diapause and migration was discussed as successive features typical for the whole population. For example: adults of some Ladybirds (Coccinellidae) migrate to hibernation quarters where proper imaginal hibernation starts (Hodek, 1962); the Bogong moth (Agrotis infusa Bsd.) migrates to mountainous areas where summer adult diapause commences (Common, 1954), etc.

So far no attempt has been made to explain the very significant evolutionary fact of when diapause and migration phenomena cause the split of a population at a certain point of ontogeny. Let us consider a species which produces a separate diapause, non-migratory population in one area, and, a non-diapause, migratory population in another area. Both populations hybridize in the zone of their occasional contact zone. The following summer generations separate, according to the genetic rules,

into original types, which have been influenced by natural selection of different seasons.

These problems have been investigated in Noctuid-moths (Lepidoptera). The synchronization of the development cycle of European Noctuidae with changing seasons is ensured by migration, or by diapause, or by both, in the necessary proportions. In the various species, differing ratios were found of diapausing individuals as compared with those migrating. Evidently the proportions of both these features change continuously among different species, but three or four groups can be defined:

1. *Species autochthonous in a certain area and having a well developed type of dormancy, usually a higher type of diapause.* Dormancy appears in one or more developmental stages. These species do not migrate across the frontiers of a particular climatic zone, or they do not migrate at all. They are distributed in the temperate and subarctic zone where the vegetation season is disconnected by a winter period. Most European Noctuids belong to this group, for example: *Scoliopteryx libatrix* L. (winter imaginal diapause), *Mamestra brassicae* L. (winter pupal diapause), *Amathes c-nigrum* L. (winter larval diapause), *Euxoa tritici* L. (winter oval diapause), *Eupsilia transversa* Hfn., *Conistra* spp. (winter imaginal and summer pupal diapause), *Rhyacia simulans* Hfn. (winter larval and summer imaginal diapause) etc.

2. *Species split into two partial populations: migrants and autochthons.* As to the proportion of diapause and migration phenomena, there are two classes:

a. The larger part of the population of an area is formed by a partial indigenous population and only a small part of the population is non-diapause of migratory origin. A good example is *Noctua pronuba* L.: Larvae of *N. pronuba* hibernate and then pupate in the spring. The adults emerge by the end of spring, the pupal stage being very short, and they undergo aestivation (summer diapause) which is induced by the photoperiod (long photophase). It was found that evidently all individuals undergo summer diapause (Novák and Spitzer, 1970). During the period of emerging and aestivation of the adults of this partial population, females with ripe ovaries sometimes appeared in Central Europe and laid fertilized eggs. These moths are probably of non-indigenous, migratory origin and come from ecologically different areas (Mediterranean). Some other *Noctua* spp. and perhaps *Scotia segetum* Schiff. belong to this category.

b. The largest part of a population of an area are migrants and only a small part of individuals forms a partial autochthonous population. A typical example is *Autographa gamma* L.: The partial autochthonous population hibernates as larvae of the 4th or lower instar which pupate in the spring. The migrants move to Central and Northern Europe from April to July, at the same time when indigenous adults appear. The partial populations — the migrants and the autochthons — partly hybridize and produce summer generations. Individuals genotypically conforming to the original migratory population move to the South in late summer and autumn. The others produce overwintering larvae within the limits of weather conditions (Novák, 1968). The relative proportions of the migrants and the autochthons vary from Southern to Northern Europe every year and perhaps orographically too.

3. *Non-diapause species which are not autochthonous, in Central and Northern Europe.* The populations of these lepidopterous insects renew by migrations every year. Examples of Noctuidae:
Scotia ipsilon Hfn., *Phlogophora meticulosa* L., *Heliothis peltigera* Schiff., *Autographa confusa* Steph. etc. Also some species of the families *Sphingidae, Pyralidae* and *Nymphalidae* belong to this group (Williams, 1958, Johnson, 1969). The adults of *S. ipsilon* Hfn. migrate to Central Europe from April to July, sometimes in several waves, and lay fertilized eggs immediately. The larval and pupal development is completed during the summer very rapidly without undergoing any kind of dormancy. The adults emerge in August and September having unripe ovaries — an initial or intermediate state of vitelogenesis. They do not lay eggs and their disappearance in October and November is explained by their migration to the South and partly by perishing in late autumn under severe seasonal conditions. Adult diapause (hibernation) seems to be improbable because of a non-diapause condition of the ovaries and of the fat reserves (Spitzer, 1969). The life history of *P. meticulosa* is similar, but the females of the summer generation sometimes lay eggs. The larvae perish later in the autumn and early winter as they are not able to hibernate.

4. In most tropical or subtropical oceanic countries (islands) with a uniform type of weather throughout the year and evergreen vegetation, only non-migratory and non-diapause insect species occur among real endemics — e.g. North Island of New Zealand (Spitzer, 1970).

In this paper, we have tried to show a simple and only preliminary ecological model of the relationship between insect migration and diapause, using our observations of Noctuidae. More autecological facts about single insect species and the investigation of the genetic mechanism of diapause and migration are needed.

REFERENCES

BROWN, E. S., BETTS, E., RAINEY, R. C. 1969, Seasonal changes in distribution of the African Armyworm, *Spodoptera exempta* (Wlk.) (Lep., Noctuidae) with special reference to Eastern Africa. *Bull. Ent. Res.* 58 (4): 661-728.

CAYROL, R. 1965, Relations existant entre les migrations et le cycle évolutif de certaines espéces de Noctuidae (Insectes Lep.). *C. r. Acad. Sci. Paris* D-260 (20): 5373-5375.

COMMON, I. F. B. 1954, A study of the ecology of the adult begong moth *Agrotis infusa* (Boisd.) (Noctuidae) with special reference to its behavior during migration and aestivation. *Austr. J. Zool.* 2(2): 223-263.

HODEK, I. 1960, Migration of Coccinelids to their hibernation quarters. *11th Int. Congr. Ent. Vienna* 1960 (3): 39-40.

JOHNSON, C. G. 1969, Migration and Dispersal of Insects by Flight. 763 pp., Methuen Co. Ltd., London.

NOVÁK, I. 1968, The hibernation of the Silver Y moth (*Autographa gamma* L., Noctuidae) under the climatic conditions of Central Europe. *13th Int. Congr. Ent., Moscow* 1968 (1): 533.

NOVÁK, I. and SPITZER, K. 1970, Unpublished data.

SPITZER, K. 1969, Some problems of the imaginal diapause in Noctuidae (Lep.). Thesis, 156 pp. (in Czech). *Czechoslovak Acad. Sci.*, Prague.

SPITZER, K. 1970, Observations on adult activity of Noctuidae (Lepidoptera) during winter in the Manawatu, N. Zealand. *N.Z. Jl. Sci.* 13 (2): 185-190.

WAY, M. J. 1962, Definition of Diapause. *Ann. appl. Biol.* 50: 595-596.

WILLIAMS, C. B. 1958, Insect Migration. The New Naturalist 36., Collins, London.

Journal of Research on the Lepidoptera 10(2):185-188, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

FURTHER NOTES ON *EUPHYES DUKESI* (HESPERIIDAE)

RODERICK R. IRWIN[1]
24 East 99th Place, Chicago, Illinois

A MINOR BUT UNFORTUNATE ERROR crept into my recent paper on *Euphyes dukesi* (Lindsey) (Irwin, "1969" [1971]). Mr. Gerald Straley of the Virginia Polytechnic Institute Extension Division has written me as follows: "I only know of a couple of places in Virginia where it [*dukesi*] is found, but one of them is along Pocaty Creek near Blackwater, in what was formerly Princess Anne County, but is now the City of Virginia Beach . . . there is no Prince Albert County, Virginia." Evidently I carelessly misinterpreted the abbreviation "P. A. Co." on the series of 7 ♂♂ 1 ♀ *dukesi* in the Carnegie Museum collection, taken at this locality by John Bauer on June 13, 1964. It is thus apparent that this record, although not previously published, is from the same general area where the species occurs in Virginia discussed by Clark and Clark (1951) and by Mather (1963). There is also a town called Blackwater in Lee County, in extreme southwestern Virginia, but it is obviously not this which is meant. My thanks to Mr. Straley.

Although this error was regrettable, its correction provides an opportunity for the publication of additional records and field notes on *E. dukesi* which were received too late for inclusion in the original paper. These are the results of the observations made by Mr. Gayle T. Strickland of Baton Rouge, Louisiana, of the occurrence of *dukesi* in that state. Mr. Strickland has very kindly given me permission to publish his data, for which I wish to express my gratitude to him. I cannot do better than to quote him directly:

"The following specimens [of *Euphyes dukesi*] were taken near the town of Denson in Livingston Parish. The nearest post office is French Settlement, La., which is 10 air-miles west and slightly north of Denson.

[1]Honorary Curator of Lepidoptera, Illinois State Museum, and Research Affiliate, Illinois Natural History Survey.

The area of the colony was small, probably less than 50 feet in diameter, and located in a shaded swamp with several inches of standing water. V-17-69, 1 ♂; V-21-69, 2 ♂♂, V-31-69, 4 ♂♂ 1 ♀; VI-15-69, 16 ♂♂ 4 ♀♀. No other visits were made to this colony.

"The following specimens were taken at Baton Rouge in East Baton Rouge Parish, La., less than one mile south of the present city limits. The area of the colony was extensive, occupying ditches on either side of a railroad for more than one-half mile. Adjacent to the railroad on the west were extensive cultivated fields. Adjacent on the east, a highway and then an extended low-lying, sometimes swampy area. There was no standing water and no shade in the area. VII-16-69, 9 ♂♂; VIII-23-69, 11 ♂♂ 3 ♀♀; VIII-29-69, 1 ♂; IX-6-69, 14 ♂♂ 8 ♀♀; IX-21-69, 9 ♂♂ 4 ♀♀; X-26-69, 7 ♂♂ 5 ♀♀; XI-2-69, 2 ♂♂ 1 ♀. At no time in either colony were specimens seen more than 15-20 feet from the foodplant (*Carex hyalinolepsis*).

"The number of specimens taken at the Denson colony is probably representative of the population density on the corresponding dates. The single ♂ taken V-17-69 was freshly emerged, and not yet fully capable of flight. A careful search for several hours produced no other specimens on this date.

"No colony sites were visited in July. The Baton Rouge colony was discovered on VIII-16-69, on which date very worn as well as fresh specimens were collected. At present I suspect that flight period is continuous in time in Louisiana from early May through early November.

"The number of specimens collected at the Baton Rouge colony is *not* representative of population density, as I made no attempt to collect all specimens seen on the various trips. On November 2 only 5 specimens were seen of which 3 were collected. No specimens were seen on November 10."

Strickland also collected *E. dukesi* at three additional Louisiana localities during 1970: 2 mi. S Epps, West Carroll Parish, VI-4-70, 2 specimens in roadside ditch with foodplant; 8 mi. SE Slidell, St. Tammany Parish, VIII-12-70, 1 ♂ on foodplant; Schriever, Terrebonne Parish, VIII-16-70, 1 ♂ on foodplant. He also captured a fresh male at the Baton Rouge locality on July 31, 1970, thus providing a record for that month.

It will be noted that the conditions under which the skipper was found at the Baton Rouge locality were widely at variance with its generally stated habitat preference, in that there was little shade and no standing water. Strickland (*in litt.*) states that "I can assure you that my 'swamp' and 'roadside' specimens are indistinguishable. There is a great deal more variation within each colony than between colonies . . . I have seen six [*sic*] colonies [the sixth evidently unreported] in Louisiana and the only thing they have in common is the foodplant. I have yet to find the foodplant without the presence of *dukesi*." Comparison of 2 ♂♂ and 2 ♀♀ from the Baton Rouge (roadside) locality with a ♂ from the Denson (swamp) habitat, which Strickland kindly sent me for study, supports his assertion. The locality at Harahan, Louisiana, described by Mather (1963), where W. D.

Fig. 1. Habitats of *Euphyes dukesi* in Louisiana. Above, Denson colony; below, Baton Rouge colony.

(Photographs courtesy Gayle T. Strickland)

Field encountered the species in 1944, appears from its description to have been somewhat similarly devoid of standing water, although perhaps more shaded, than the Baton Rouge habitat.

Pliske ("1957" [1958]) states that the host of *E. dukesi* in the Michigan locality where he studied the species is *Carex lacustris*. According to Jones and Fuller (1955), this sedge does not occur south of Ohio and Illinois, and is perhaps more strongly confined to true swamp environments than is the closely related and more widely ranging *C. hyalinolepis,* which the observations of Strickland indicate is the host utilized by *dukesi* in Louisiana. It therefore seems likely that the occurrence of *E. dukesi* in comparatively dry situations is more frequent than has previously been believed, and that the presence of standing water in its habitat is not an inherent biological requirement of *dukesi,* but merely a function of the differing environmental characters of its discrete hosts in various parts of its range.

The five Louisiana *dukesi* sent me by Strickland, as well as all of the four presently known Illinois specimens, have been placed in the collection of the Illinois Natural History Survey.

LITERATURE CITED

CLARK, AUSTIN H., and LEILA F. CLARK (1951). The butterflies of Virginia. *Smithsonian Misc. Coll.* 116(7): 1-239.

IRWIN, RODERICK R. ("1969" [1971]). *Euphyes dukesi* and other Illinois Hesperiidae. *J. Res. Lepid.* 8: 183-186.

JONES, GEORGE N., and GEORGE DAMON FULLER (1955). Vascular plants of Illinois. *Museum Scientific Series,* Vol. VI. University of Illinois Press, Urbana, and Illinois State Museum, Springfield. xii + 593 pp. 1375 maps.

MATHER, BRYANT (1963). *Euphyes dukesi,* a review of knowledge of its distribution in time and space and its habitat. *J. Res. Lepid.* 2: 161-169.

PLISKE, THOMAS ("1957" [1958]). Notes on *Atrytone dukesii* [*sic*], a rare species new to southern Michigan (Hesperiidae). *Lepid. News* 11: 42.

Journal of Research on the Lepidoptera 10(2):189-190, 1972

1160 W. Orange Grove Ave., Arcadia, California. U.S.A.

IS AIR POLLUTION RESPONSIBLE FOR MELANISM IN LEPIDOPTERA AND FOR SCARCITY OF ALL ORDERS OF INSECTS IN NEW JERSEY?

JOSEPH MULLER

R. D. 1, Lebanon, New Jersey

About forty years ago some very light forms of moths were collected in New Jersey by the late Messrs. Otto Buchholz, Frederick Lemmer and Charles Rummel. In thirty-five years of collecting all over New Jersey I have never found those light forms in the wild, nor have I seen them in any other recent collections. Some of these moths were the very light form of *Catocala connubialis* Gn., a very light form of *C. ilia* Cram. from Lakehurst, and the nearly white female of *Nacophora quernaria* A. & S.

During my years of collecting I found that *Catocala connubialis* first changed to the dark form *pulverulenta* Br. and lately to all melanic *broweri* M. *C. ilia* changed to gray and blackish forms. Females of *N. quernaria* changed to the melanic form *atrescens* Hulst. Only a few male *N. quernaria* show some light crosslines. Many more light forms of moths have changed to melanistic and melanic forms during recent years. Furthermore these dark forms seem to be on the increase, especially in some Noctuid genera such as *Acronicta.*

Several theories about the cause of melanism have appeared in different journals: genetic isolation, adaptation to dark surroundings and industrial melanism (now called smog). In some areas one or two of these influences may have combined.

The southern part of New Jersey is all flat and consists of orchards, blueberry and cranberry farms, scrub oak barrens and some patches of forest. There are only a few industries, and they do not produce enough smog to obscure the sun. What little smog there is, will be swept away by strong winds or convection. In this part of New Jersey only a few dark forms of moths occur.

In the northern part of the state it is a different story. New Jersey, the most densely populated state in the country, has also the most automobiles per citizen. These cars and hundreds of buses and trucks passing through to New York are concen-

trated here and seem to be the cause of the worst air pollution. Only 40 to 50 miles from where I live are three large jet airports sending 1 to 5 jets overhead every minute in Hunterdon Co., N. J. Two miles before reaching the Newark meadows one can see and smell the smoke caused by burning garbage. Finally, most of the factories in New Jersey are located in the northern part. The Department of Air Resources publishes a daily smog index in the New York Daily News. It indicates air conditions which are good, acceptable, unsatisfactory or unhealthful. I picked seven days at random with these results: 4 days unhealthful, 2 days unsatisfactory, and one day acceptable.

I believe that air pollution combined with aerial spraying of insecticides over the whole state is responsible for a sharp decrease in Lepidoptera and all other orders of insects. In Hunterdon County alone, where I live, seven areas are routinely sprayed. It hardly pays to put up my black lights. Even toads feeding on insects on the ground and bats catching them in the air are scarce. Only a few years ago my lights were loaded with so many insects, especially small Diptera and Coleoptera, that I could hardly breathe. Those times seem to be gone forever.

CONCLUSION

In southern New Jersey, where there are hardly any industries, Lepidoptera of "normal" forms are dominant, for they are adapted to the open light surroundings. The few dark forms, mostly singletons, might come from dense patches of forest. In the northern part of the state, where more melanic forms appear in greater numbers than in the southern part, the question "Is air pollution responsible for melanism in Lepidoptera and for scarcity of all Orders of insects" is still open and cannot be answered unequivocally. My own belief is that smog alone, which filters out some components of sunlight, is the major cause of melanism. I believe that smog and spraying of insecticides combined, are responsible for the scarcity of insects. No changes have been found in vegetation so far, as I was told by an eminent botanist, except that lichens are diminishing in the metropolitan area.

REFERENCES

KLOTS, A. B. 1966. Melanism in Connecticut *Panthea furcilla* Pack. *Jour. N.Y. Ent. Soc.* 74:95-100.

———— 1968. Melanism in Connecticut *Charadra deridens* (Gn.). *Jour. N.Y. Ent. Soc.* 76:58-59.

MULLER, JOSEPH. 1967. Melanism in New Jersey *Catocala* Schrank. *Jour. N.Y. Ent. Soc.* 75:195-196.

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distrilutional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W.J. Reinthal and J.T. Mithell. Send data to Dr. W.J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U.S.A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P.O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P.O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W. T. M. Forbes. Entomological Reprint Specialists. P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B. M. Endicott. Distributed in U.S.A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P.O. Box 433, New York, N.Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A.I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

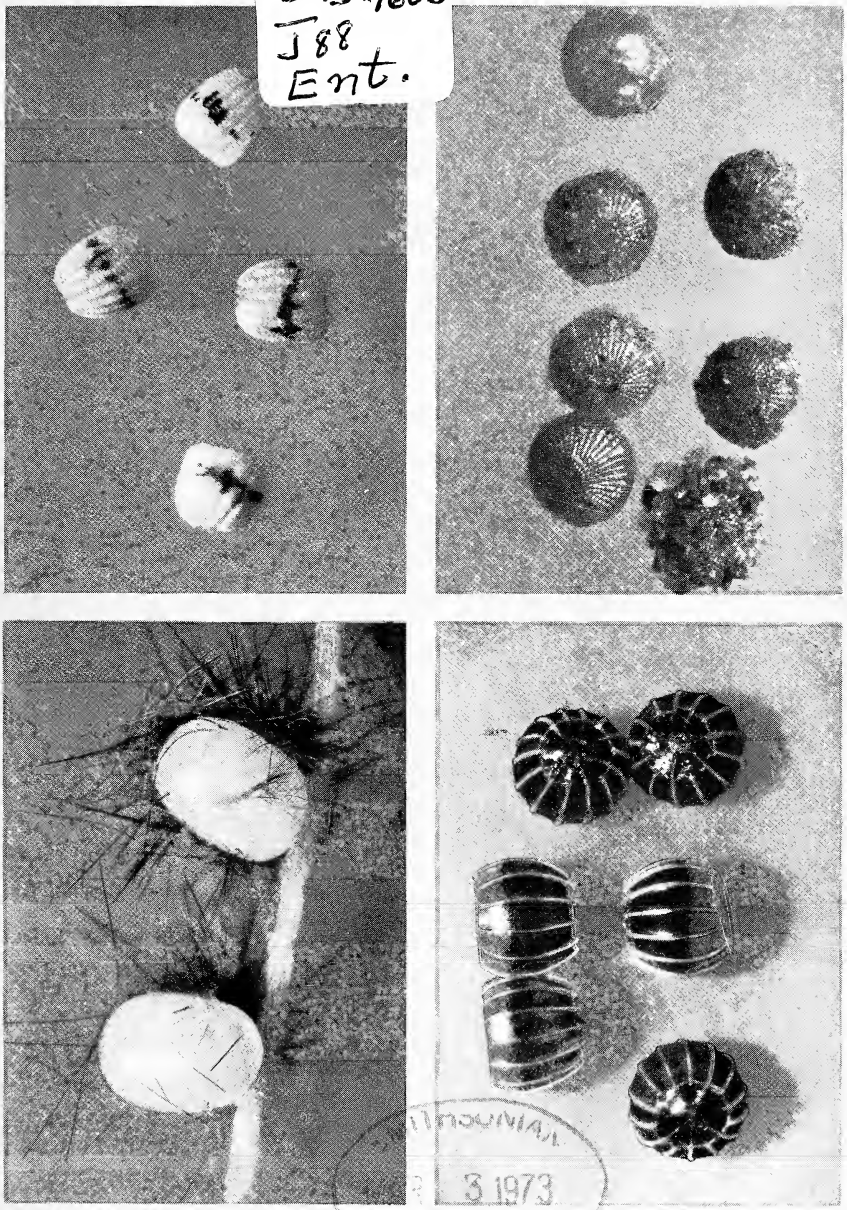
Centurie de Lepidopteres de L'ile De Cuba. P.H. Poey, 1832. C.W. Classey, 353 Hanworth Road, Hampton, Middlesex, U.K. in the U.S.A. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 10 *Number 2* *June, 1971 (1972)*

IN THIS ISSUE

THE JOURNAL
OF RESEARCH
ON THE LEPIDOPTERA



Volume 10 Number 3 September 1971 (1973)

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 10(3):191-202, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

A CHECKLIST OF UTAH BUTTERFLIES AND SKIPPERS

CURTIS J. CALLAGHAN
2500 Kensington Ave., Salt Lake City, Utah

and

KENNETH B. TIDWELL
969 Colmar Ave., Salt Lake City, Utah

THE STATE OF UTAH is a very interesting area for the study of butterflies. Its 84,916 square miles of mountains, plateaus, and deserts is a region of considerable diversity of climate and vegetation representing every life zone from Arctic-Alpine to Lower Sonoran. Within this floral range are habitats of a large number of species of butterflies of which 175 have been recorded. The relative inaccessability of many areas in the State has limited collecting in the past and thus provides numerous virgin territories for the lepidopterist to explore.

The State of Utah includes parts of three great physiographic provinces of the Western United States: the Great Basin, portion of the Basin and Range Province in the west, the Rocky Mountains in the northeast, and the Colorado Plateau Province in the south and southeast. A line following the almost continuous front east of U.S. Highway 91 through Ogden to a point a few miles south of Cedar City marks the east boundary of the Great Basin part of the Basin and Range Province. The Great Basin has interior drainage with the Great Salt Lake as the lowest portion (4197 feet). The boundary of the Province turns abruptly westward south of Cedar City to the Beaver Dam Valley and thence along the Grand Wash Cliffs in Arizona.

The Rocky Mountain Province includes the Wasatch and Uintah mountains and extends as far south as Nephi and the south side of the Uintas. Altitudes reach more than 11,000′ in the Wasatch and more than 13,000′ in the Uintas. The Alpine

zone in the latter contains Utah's only examples of true alpine butterfly fauna. While other ranges in the State go over 12,000′, typical alpine forms are notably lacking.

The Great Basin is characterized by isolated mountain ranges rising above desert valleys. The lowest part of the desert valleys is occupied by the Great Salt Lake from which the mean altitude rises about 1000′ to the south. The desert ranges rise to variable altitudes, mainly 7,000′ to 9,500′ although some peaks in the Stansbury and Deep Creek ranges rise to over 11,000′ and 12,000′ respectively. Though the valleys and lower ranges have a desert climate with less than 14 inches of rainfall, the high ranges reach above the tree line and have more than 30 inches and permanent to semi-permanent streams. Vegetation is mainly Upper Sonoran juniper-pinon forests with small areas of Canadian zone vegetation above 8000′.

The western part of the Colorado Plateau is aptly named the High Plateau for it reaches altitudes of more than 10,000′. The highest point is over 12,000′ in the Tushar Mountains well above the treeline, where precipitation exceeds 30 inches. The upland areas are characterized by aspen, pine and balsam-spruce forests with open mountain meadows. Many streams are permanent and for the most part flow into the Sevier River which in turn finds its way into the Great Basin. A prominent escarpment overlooking the Canyonlands of the Colorado Plateau marks the east and south sides of the High Plateau.

The Canyonlands are characterized by deep dissection by the Colorado River and its tributaries, including the Virgin River which drains the southwest corner of the State. The area south of St. George has the lowest elevation in the State and brings many Lower Sonoran desert plants and animals within Utah borders. Most of the Canyonlands area lies below 8000′. But three groups of mountains, each characterized by masses of intrusive rocks, rise to altitudes of more than 10,000′. These include the La Sals (12,721′), Abajo, and Henry groups of mountains. The Uinta Basin is separated from the Canyonlands by the bold escarpment of the Book Cliffs north of Price and Green River, Utah.

The following list of Utah butterflies was compiled from the records of a number of private collections. These were primarily those of the authors, John Emmel and Oakley Shields. Don Eff provided records from the F. M. Brown and W. N. Burdick collections in the Museum of the University of Colorado. The nomenclature follows the dos Passos List (1964)

except for those groups and species which have undergone revision since its publication. The Lycaenidae were reviewed by Harry K. Clench and the Hesperiidae by Lee D. Miller. The authors are particularly grateful to Don Eff, F. Martin Brown, John Downey, and Cyril F. dos Passos who made many useful comments on the total list. Finally, George F. Edmunds of the Department of Biology, University of Utah offered many suggestions regarding form and taxonomy.

For the purpose of recording the geographic occurence of species, the State has been mapped into 20 zones which form the habitats of different ecological groupings of its butterfly fauna. Under each zone, following a description, are listed the principal collecting localities from which the butterflies were taken. For each species the arabic numbers refer to zones of occurrence; specific localities are mentioned under a species only if there is a single record. Flight periods are shown by giving the months in Roman numerals. The small case letters indicate relative abundance of each species: (c) common, (u) uncommon, (r) rare, and (d) doubtful occurence.

The zones referred to in the text are as follows:

1. Raft River mountains, Box Elder County, elev. 5000′ to 9000′; Upper Sonoran *Juniperus* association to Canadian Zone. Locality: Clear Creek Canyon.
2. Mountainous areas of Cache, Rich, and Weber counties, elev. 5500′ to 8000′; Upper Sonoran oak association to Canadian Zones. Localities: Logan Canyon drainage, Bug Lake, Cottonwood Canyon (Rich Co.), 10 mi. S. of Avon (Cache Co.).
3. Intermountain park areas of Summit and Wasatch counties; rolling sage and grasslands around 6000′. Localities: Snyderville, Park City, 6600′.
4. Wasatch Mountains, west drainage, from Davis to Utah counties including the Salt Lake Valley. Upper Sonoran oak Canadian and Alpine zones; elev. 5500′ to 9000′. Localities: Records from all the canyons along the Wasatch Front; Alta, Brighton, Little Mountain.
5. Stansbury Mountains, Tooele County, elev. 5000′ to 8000′, Upper Sonoran *Juniperus* association and Canadian zones. Localities: South Willow Creek; North Willow Creek.
6. The other Great Basin ranges extending from Tooele County southward to Washington County, elev. 6000′ to 7000′. Areas are characterized by Upper Sonoran *Juniperus* association with sage and grasslands higher up. Localities: Cedar Mountains, Granite Mountain, Bennion Creek, Sheep Rock Mountains. (Tooele Co.).
7. Deepcreek Mountains, western Juab and Tooele counties, elev. 6000′ to 10000′. Sonoran *Juniperus* association and aspen Canadian zone with small fir forests. Alpine flora on highest peaks. Localiy: Thoms Canyon.
8. Uintah Mountains, Summit, Wasatch, Duchesne, and Uintah counties, elev. 6000′ to 10000′. Upper Sonoran oak or *Juniperus* depending on the amount of rainfall, Transition Zone of yellow pine, and typical aspen Canadian zone with douglas and white pine below 8000′ and with Engleman spruce, lodgepole pine above. Localities: South &

North Forks of the Provo River; East Fork of Bear River, (Summit Co.); Soapstone Mountain, (Wasatch Co.); Bush Creek, Ashley Creek, (Uintah Co.); Duchesne River, (Duchesne Co.).

9. Uintah Mountain above 10000′, Alpine zone. Localities: Bald Mountain, (Summit Co.); Leidy Peak, (Uintah Co.).
10. Extension of the Yampa Plateau into the northwest corner of Uintah County, elev. 7000′ to 8000′. Vegetation is mixed oak and *Juniperus* with some aspens. Localities: Dinosaur National Monument.
11. Uintah Basin south to the Tavaputs Plateau, elev. 5000′ to 7500′. Uintah County. Mostly desert vegetation with juniper and pinon in the higher elevations. Localities: Willow Creek, Bonanza, Jensen, Grassy Trail Creek, (Carbon Co.).
12. La Sal and Abajo Mountains of Grand and San Juan Counties, elev. 6000′ to 10000′. Upper Sonoran oak and *Juniperus* association and fir and aspen Canadian zones. Localities: Warner Ranger Station, 9750′; Pack Creek, 6000′ (La Sal mts.); Buckboard Flat, 9600′ (Abajo Mts.).
13. Henry Mountains, Garfield County elev. 5000′ to 10000′. Mostly Upper Sonoran *Juniperus* and oak with a small aspen and fir Canadian zone present. Locality: Bull Creek.
14. Aquarius Plateau, Garfield County, elev. 5000′ to 11000′. Upper Sonoran zone, prominent Transition zone of pondersa pine and aspen Canadian zone with white fir. Grass land above 10000′. Localities: Rogers Peak, 10000′.
15. Wasatch Plateau, elev. 6000′ to 10000′. Oak, Canadian zone with sagebrush flats to 10000′. Localities: Big Spring Wash (Emery Co.); Ivie Creek, Last Chance Creek, (Sevier Co.); near Mt. Sanpete, (Sanpete Co.).
16. Tushar Mountains, Beaver and Piute Counties, 6000′ to 12000′. Upper Sonoran juniper and oak, Transition and Canadian zones. Localities: Kent's Lake, 9750′, Puffer Lake.
17. Markgunt Plateau, elev. 7800′ to 9000′. Vegetation is ponderosa Transition zone with yellow pine. Aspen and fir Canadian zone above 8500′. Localities: Cedar Breaks National Monument, Brian Head ski area.
18. Pine Valley Mountains, Washington County, elev. 3500′ to 10000′. Mostly Upper Sonoran oak and *Juniperus* associations with some Transition and aspen and white fir Canadian zone above. Localities: Leeds Canyon, Red Cliffs Park, 3500′; Pine Valley, 4500′, Oak Grove Campground.
19. Lower Sonoran instrusion from St. George, Washington County, to the Arizona border, elev. 2500′ to 3000′. Creosote bush, barrel cactus, joshua trees and live oak. Localities: *circa* St. George; Virgin River to Arizona border; Beaver Dam Mountains, south slope.
20. Upper Sonoran to Transition Zones of Kane, San Juan, and the eastern edge of Washington Counties, north to Sevier and Carbon Counties, elev. 3500′ to 6000′. *Juniperus* association with drier desert areas, sage (*Artemisia* sp.) and black brush. Localities: entrance to Zion National Park, Kanab; Navajo Mountain Natural Bridges National Monument; and the Canyonlands National Park area, San Raphael Desert.

REFERENCES

BROWN, F. MARTIN, 1957. Colorado Butterflies. 368pp. *Proc. Denver Mus. Natural History*, Denver, Colo.

————, 1967. Dr. Edward Palmer's collecting localities in southern Utah and northwestern Arizona. *Jour. Lepidop. Soc.* 21:129-134.

BROWNING, G. WESLEY, 1901. Collecting in the vicinity of Salt Lake City, *Ent. News*, 12(10): 297-304, pl. XIII.

BURNS, JOHN M., 1964. Evolution of the skipper butterflies of the genus *Erynnis. Univ. Calif. publ. Entomology,* 37: 1-214.

DOS PASSOS, Cyril F., 1964. A Synonymic List of the Nearctic Rhopalocera. *Lepidop. Soc., Mem.* No. 1.

________, 1969. A Synonymic list with taxonomic notes concerning the Nearctic Melitaeinae (Nymphaloidae). *Journ. Lepidop. Soc.* 23: 115-125.

________, 1970. A Revised synonymic catalogue with taxonomic notes on some Nearctic Lycaenidae. *Journ. Lepidop. Soc.* 24: 26-38.

DOWNEY, JOHN C., 1962. Myrmecophily in *Plebejus (Icaricia) icariodes* (Lepid: Lycaenidae), *Ent. News,* LXXIII: 3, 57-66.

________ & DAVID B. DUNN, 1964. Variation in the Lycaenid butterfly *Plebejus icarioides* III. Additional data on foodplant specificity. *Ecology* 45: 173-178.

CLENCH, HARRY K., 1967. Further distribution records and taxonomic notes on *Philotes rita* (Lycaenidae), *Journ. Lep. Soc.,* 21: 141-142.

EHRLICH, P. R. and A. H. EHRLICH, 1961. *How to know the butterflies,* 262pp. Wm. C. Brown Co. Dubuque, Iowa.

EMMEL, THOMAS C., 1969. Taxonomy, distribution and biology of the genus *Cercyonis* (Satyridae.) I, Characteristics of the genus, *Journ. Lepidop. Soc.* 23: 165-175.

GREY, L. P. and A. H. MOECK, 1962. Notes on overlapping subspecies I. An example in *Speyeria zerene, Journ. Lepidop. Soc.* 16: 81-97.

________ & CYRIL F. DOS PASSOS, 1947. Systematic catalogue of *Speyeria* (Lepidoptera, Nymphalidae) with designations of types and fixation of the type localities, *Amer. Mus. Novitates* 1370: 1-30.

HOLLAND, W. J., 1902. *The Butterfly Book,* Doubleday, New York.

KNOWLTON, G. F., 1939. Lepidoptera (of Utah), *Utah Agric. Exper. Station, Mimeograph Series* 200 (Tech.), Part 2. March 1939. pp 1-14.

LANGSTON, ROBERT L., 1969. *Philotes* of North America: synonymic list and distribution (Lycaenidae), *Journ. Lepidop. Soc.* 23: 49-62.

MATTONI, R. H. T., 1966. Distribution and pattern of variation in *Philotes rita, Journ. Res. Lepid.* 4(2): 81-102 ("1965").

OPLER, PAUL A. and JERRY A. POWELL, 1961. Western components of the *Apodemia mormo* complex, *Journ. Lepidop. Soc.* 15: 145-171.

OPLER, PAUL A., 1968. Studies on the Nearctic *Euchloe,* Part 5, *Journ. Res. Lepid.* 7: 65-86.

PERKINS, S. F., & E. M. PERKINS JR., 1967. Revision of the *Limenitis weidemeyerii* complex, with description of new subspecies (Nymphalidae), *Journ. Lepidop. Soc.* 21: 213-234.

SCUDDER, SAMUEL H., 1878. Notice of the butterflies collected by Dr. Edward Palmer in the arid regions of Southern Utah and Northern Arizona during the summer of 1877, *U.S. Geol. Surv. Ter. Bull.,* 4: 253-258.

Season Collecting Summaries—Lepidopterists Society, 1947-1969.

TILDEN, J. W. and J. C. DOWNEY, 1955. A new species of *Philotes* from Utah, *Bull. So. Calif. Acad. Sci.,* 54: 25-29.

WOODBURY, A. M. 1952. Gazetteer of Utah Localities and Altitudes, Division of Biology, University of Utah, Salt Lake City.

LIST OF BUTTERFLIES AND SKIPPERS

Superfamily HESPERIOIDEA

Family MEGATHYMIDAE

1. *Agathymus alliae* (Stallings & Turner) 18; ix; (r). Foodplant is *Agave utahensis* Engelm.
2. *Megathymus coloradensis browni* Stallings & Turner 15, 20; iv-v; (u). Foodplant is *Yucca harrimaniae* Trelease.
3. *Megathymus yuccae* ssp. 18; iii; (r).

Family HESPERIIDAE

Subfamily HESPERIINAE

4. *Lerodea eufala* (Edwards) 19; viii-ix; (u).
5. *Atryonopsis deva* (Edwards) 18, 20; v; (r).
6. *Poanes taxiles* (Edwards) 5, 12, 18; vi-vii; (u).
7. *Ochlodes yuma* (Edwards) 17, 20; viii; (u).
8. *Ochlodes sylvanoides napa* (Edwards) Statewide in the mountains at lower elevations; viii-ix; (c).
9. *Atalopedes campestris* (Boisduval) 19; vi; (u).
10. *Polites sabuleti chusca* (Edwards) 4, 8, 12, 15; double brooded, v, viii-ix; (c). Especially in populated areas on lawns.
11. *Polites draco* (Edwards) 1, 2, 4, 8, 12, 14; vi-vii; (u).
12. *Polites siris utahensis* (Skinner) 2, 3; vi-vii; (u).
13. *Polites themistocles* (Latreille) 2, 3; vi-vii; (u).
14. *Hesperia uncas* Edwards 15, 20; vi-vii; (u).
15. *Hesperia comma idaho* (Edwards) 2, 3, 5, 8, 12; viii; (c).
16. *Hesperia nevada* (Scudder) 8, 12, 13; v-vi; (u).
17. *Hesperia comma ruricola* Boisduval 4; vi-vii; (r).
18. *Hesperia pahaska martini* 12; vi; (r). One record from Pack Creek, La Sal mts.
19. *Hylephila phyleus* (Drury) 19; viii; (u).
20. *Copaeodes aurantiaca* (Hewitson) 19; v-vi; (u).
21. *Oarisma garita* (Reakirt) 2, 3, 4, 8, 15, 16, 20; vi-vii; (u).
22. *Oarisma edwardsi* (Barnes) 20; vii; (d).
23. *Piruna pirus* (Edwards) 4; vi; (u). Probably more widespread.

Subfamily PYRGINAE

24. *Staphylus ceos* (Edwards) 20; vii; (d).
25. *Pholisora catullus* (Fabricus) Statewide in the mountains; vii; (c).

26a. *Pholisora libya libya* (Scudder) 19; Double-brooded vi, viii; (u).

26b. *Pholisora libya lena* (Edwards) 11, 12; vi-vii; (u).

27. *Helioptes ericetorum* (Boisduval) 4, 18, 20; Double-brooded v-vi, viii; (u).
28. *Pyrgus centaureae loki* Evans 9; viii; (u).
29. *Pyrgus ruralis* (Boisduval) 3, 4, 8, 14; vi; (r).
30. *Pyrgus xanthus* Edwards 4; v; (r).
31. *Pyrgus scripta* (Boisduval) 18; v; (r).

32a. *Pyrgus communis communis* (Grote) Statewide vi-viii; (c).

32b. *Pyrgus communis albescens* Plotz 5, 6; vi-vii; (u). Probably more widespread.

33. *Erynnis icelus* (Scudder & Burgess) 4, 8, 14: v-vi; (u).
34. *Erynnis brizo burgessi* (Skinner) 4, 5, 16, 17; iii-vi; (u).
35. *Erynnis persius* ssp. 5, 6, 18, 20; vii; (c). There may be several ssp. here. Only knowledge of the foodplant will enable determination of which ssp. are involved.
36. *Erynnis lucilius afranius* (Lintner) 2, 3, 4, 5, 8; Double-brooded v, vii-viii; (c).

37. Erynnis telemachus Burns Statewide in the mountains; iv-vi; (c).
38. Erynnis tristis tatius (Edwards) 20; vi; (u). Recorded only from Navajo Mountain.
39. Erynnis pacuvius pacuvius (lintner) 8, 20; vi; (u).
40. Erynnis zarucco funeralis (Scudder & Burgess) 20; iv; (u). Recorded only from Zion Nat. Park.
41. Thorybes pylades (Scudder) 4, 12; vi; (u).
42. Thorybes mexicans nevada Scudder 3, 4, 8, 12; vi; (c).
43. Epargyreus clarus (Cramer) 4; vi; (u).

Superfamily PAPILIONOIDEA

Family PAPILIONIDAE

Subfamily PARNASSIINAE

44. Parnassius clodius menetriesii Edwards 2, 4, 8; vi-viii, depending on elevation; (c).
45a. Parnassius phoebus savii Edwards 2, 4, 5, 8; vi-viii; (c). More local than clodius.
45b. Parnassius phoebus hollandi Bryk & Eisner 12; vi; (c) local.

Subfamily PAPILIONINAE

46. Papilio bairdii bairdii Edwards 5, 11, 18, 20; vi-vii; (r). form brucei Edwards 5, 11; v-vii, (c). Becomes more dominant from south to north. Fond of hilltopping.
47. Papilio rudkini rudkini J.A. Comstock 19, iii; (u). form clarki Chermock & Chermock 19, iii; (r). Fond of hilltopping. Foodplant is Thamnosma montana Torr. & Frem. ex Frem.
48a. Papilio rutulus rutulus Lucas Statewide in the mountains; vi-vii; (c).
48b. Papilio rutulus arizoniensis Edwards 18; vii; (c).
49a. Papilio indra indra Reakirt 5; vi; (r). Only recorded from South Willow. Probably more widespread.
49b. Papilio indra minori Cross 20, (Moab); iv, vii, double brooded; (u).
49c. Papilio indra nr. martini 18; iv; (r). John Emmel reports finding the larvae on Lomatium Parryi macbr. at Oak Grove Campground.
50. Papilio zelicaon Lucas 2, 4, 5, 6, 13; iv-vii, (u). May be double brooded. Foodplant is Lomatium greyi Coult.
51. Papilio multicaudata Kirby Statewide in the mountains to 9000ß; vi-vii; (c).
52. Papilio eurymedon Lucas 2, 4; vi-vii; (u).

Family PIERIDAE

Subfamily PIERINAE

53. Pieris beckerii Edwards Statewide; three broods, iv, vi, viii; (c) The early spring form is pseudochloridice McDunnough
54a. Pieris sisymbrii 6, 11, 19, 20; iv, v, always in desert areas. (c). This butterfly is larger and more heavily marked than typical California. P.S. sisymbrii Boisduval
54b. Pieris sisymbrii elivata (Barnes & Benjamin) Statewide above 6000'; v-vi; (c).
55. Pieris protodice protodice Boisduval & LeConte Statewide probably multiple brooded; v, viii. (c).
56a. Pieris occidentalis occidentalis Reakirt Statewide in the mountains to 8000'; multiple brooded; vi-viii. (c).
56b. Pieris occidentalis calyce Edwards 4, 9; vi, vii; (u)
57. Pieris rapae (Linnaeus) Statewide near agricultural areas; iv, viii, multiple brooded; (c).

58. Pieris napi macdunnoughi Remington Statewide in the mountains; v-vi; (c).

Subfamily COLIADINAE

59. Colias meadii meadii Edwards 9; vii-viii; (u).
60. Colias eurytheme eurytheme Boisduval Statewide near agricultural areas; v-viii; (c).
61. Colias philodice eriphyle Edwards Statewide, mainly in the mountains; v-ix; (c).
62. Colias scudderii scudderii Edwards 9; vii-viii; (u).
63a. Colias alexandra alexandra Edwards 13, 14, 15, 16; vi, vii; single brooded; (u). The exact status of alexandra and its subspecies in Utah to my knowledge has not yet been fully worked out. Thus, its distribution must remain tentative for the present.
63b. Colias alexandra edwardsii Edwards 2, 5, 6, 7; v, viii; double brooded. The habitat is dry foothill country (in the Great Basin) with Juniperus association.
63c. Colias alexandra astraea Edwards 8; transition zone; vii; (u).
64. Colias (Zerene) caesonia (Stoll) 18, 12; vi; (r).
65. Nathalis iole Boisduval 4,5, 8, 12, 13, 18; vi-vii; (c), (u).

Subfamily EUCHLOEINAE

66a. Anthocaris sara nr. thoosa Scudder 6, 7, 18; vi-vii; (c) (u).
66b. Anthocaris sara julia Edwards 8; Inhabits sagebrush flats at Brush Creek; v-vi; (u).
66c. Anthocaris sara browningi Skinner 2, 4, 8, 15; iv-vi; (c).
67. Euchloe hyantis lotta Beutenmuller 6, 7, 18; iv-vi; (c). This designation follows Opler, (1966).
68. Euchloe ausonides Lucas 2, 3, 4, 5, 8, 12, 13, 18; iv, early vii; (c). Found moist canyons in the oak belt above 5800'.

Family RIODININAE

69. Apodemia mormo mormo (Felder & Felder) 4,5,8,12,19,20; Double brooded v, viii; (u) local. In Southwestern Utah, (19), the larvae overwinter in the stems of Eriogonum inflatum. Torr. and Frem. ex Frem.
70. Apodemia palmerii palmerii (Edwards) 19; double brooded v, viii; (u). Common on mesquite (Prosopsis sp.).

Family LYCAENINAE

Subfamily THECLINAE

71. Habrodais grunus (Boisduval) 18; vii; (d). Reportedly found in the live oak canyons near St. George. No recent records have been discovered, however.
72a. Hypaurotis crysalus crysalus Edwards 17, 18; vii-viii; (u). 6000' to 7000'.
72b. Hypaurotis crysalus citima (H. Edwards) 4; vii; (u). The Great Basin form, found in Oak canyons on the western slope of the Wasatch range.
73. Atlides halesus estesi Clench 18; iii-vi; (r). Found commonly on Manzanita blooms, (Arctostaphylos sp.), in areas where misletoe (Loranthaceae sp.) is common.
74. Satyrium behrii crossi Field 2, 3, 4, 12, 18; vi-vii; (u).
75. Satyrium fuliginosum semiluna Klots 1, 8; vi-vii; (r), very local.
76. Callophrys (Mitoura) spinetorum (Hewitson) 4, 5, 8, 18; vi; (r).
77. Callophrys (Mitoura) siva siva (Edwards) 4, 5, 7, 13, 17, 18; vi; (c). Typical siva are found in the Colorado

Plateau area in the eastern half of the State. The Great Basin specimens differ in that they lack the typical green underside approaching the color of C. nelsoni. (Boisduval) from California. Whether or not the Great Basin material should be named must await further study.

78. Callophrys (Incisalia) iroides (Boisduval) 2, 4, 8, 15; iv-v; (u). Clench informs me that Utah specimens are half way between C.i. augustinus (Westwood)and typical iroides. Food plant is Manzanita (Arctostaphylos sp.).
79. Callophrys (Incisalia) fotis fotis (Strecker) 6, 18; iii-iv; (u), on Cliffrose (Gowania mexicana Don)
80. Callophrys (Incisalia) eryphon eryphon (Boisduval) 2, 4, 8; vi; (u).
81. Strymon melinus ssp. Statewide at lower elevations, 5000' to 7000'; multiple brooded v-ix; (u).
82. Chrysophanus titus immaculosus Comstock 1, 2, 4, 8; vi-vii; (u) local.
83. Satyrium californica (Edwards) 1, 2, 5; vi-vii; (u) local.
84. Satyrium sylvinus putnami (H. Edwards) 1, 2, 4, 5, 8; vi-viii; (c).
85. Satyrium saepium provo (Watson & Comstock) 1, 2, 4, 18; vii; (u). Southern specimens are larger and more distinctly marked. They may require a different designation.
86. Callophrys (Callophrys) comstocki Henne 19; iii, local. Recorded only from Beaver Dam Mountain.
87. Callophrys (Callophrys) affinis affinis (Edwards) 1, 2, 4, 5, 8, 10; vi; (u).
88. Callophrys (Callophrys) sheridanii neoperplexa Barnes & Benjamin. 4, 8; iv-v;(r) very local.

Subfamily LYCAENINAE

89. Lycaena arota shellbachi Tilden 2, 4, 5; vii-viii; (u).
90a. Lycaena heteronea heteronea Boisduval 2, 4, 7, 8, 12, 15; vi-viii; (c).
90b. Lycaena heteronea gravenotata Klots 17; vii; (c).
91. Lycaena editha montana Field 2, 3, 4; vii; (u).
92. Lycaena rubidus sirius (Edwards) 2, 4, 5, 8, 15; vii-viii; (c). There are two populations of this species, one low (5000') and the other high montain (above 85000').
93. Lycaena nivalis browni dos Passos 2, 4, 8, 12, 15; vii-viii; (c).
94. Lycaena helloides (Boisduval) Statewide; vi-viii; (c).
95. Lycaena cupreus (Edwards) 3, 9; vi, vii-viii; (r). There are two distinct populations of this species in Utah, one high altitude and the other lower (6500'), the former with larger and darker markings on the underside than the latter. Both are smaller than Colorado L.c. snowi Edwards and more heavily marked.

Subfamily PLEBEJINAE

96. Brephidium exilis (Boisduval) 5, 11, 19; vii-viii; (u).
97. Leptotes marina (Reakirt) 5, 6, 19; vii-viii; (u).
98. Hemiargus ceraunus gyas (Edwards) 19; vii; (u).
99. Hemiargus isola alce (Edwards) 16, 17, 18, 19: vi-vii; (u).
100a. Lycaeides melissa melissa (Edwards) Statewide vi-viii; (c). Multiple brooded.
100b. Lycaeides melissa annetta (Edwards)4; vii; (r). Found only in the Wasatch Front Range, above 8000'.
101a. Plebejus saepiolus saepiolus (Boisduval) 2, 4, 7, 8, 9, 15; vi-viii; (c).
101b. Plebejus saepiolus gertschi dos Passos 13, 14, 16, 17, 18; vi-vii; (c).
102. Icaricia icarioides ardea (Edwards) Statewide in the mountains; vi-vii; (c). Feeds on lupine-larvae associated

with ants of the genus Formica in Big Cottonwood and Emigration Canyons, Salt Lake County. (Downey, 1962).

103. Icaricia shasta (Edwards) 1, 6, 7, 10, 15; vi-vii; (r). In Utah, I. Shasta is not found above 7500', but usually occurs in the juniper-pinon belt in the foothills. The only exception is a record from Mt. Sanpete. The high altitude form minnehaha (Scudder) has not as yet been recorded from Utah.

104. Icaricia acmon lutzi dos Passos Statewide in the mountains; vi-vii; (u). The females are quite rarely collected.

105. Agriades glandon rustica (Edwards) Statewide in the mountains: vi-vii; (c).

106. Everes amyntula albrighti Clench 2, 4, 7, 8, 12, 15, 18; v-vi; (c).

107. Philotes spaldingi Barnes & McDunnough 4, 17; vii; (r). Prefers juniper-pinon areas.

108. Philotes enoptes ancilla Barnes & Mcdunnough 3, 4, 5, 6, 8, 15; vi-vii; (u). Found in moist meadows on Eriogonum sp. around 7000'.

109a. Philotes rita pallescens Tilden & Downey 6; viii; (r). In juniper areas around 6000' on Erigonum sp.

109b. Philotes rita ssp. 20, San Rafeal Desert; villi; (u), local. The undersides of the wings are darker than on P.r. pallescens.

110a. Philotes battoides centralis Barnes & Mcdunnough 11; viii; (r). Usually found in arid, treeless areas on Benth. E. corybosum; 5400'.

110b. Philotes battoides ssp. 20; vii-ix; (u). This butterfly is widespread in Kane and San Juan counties. It may be synonomous with what I have called centralis above. Oakely Shields is working on these at present, so final judgement must await the outcome of his investigation.

111. Scolitantides piasus daunia (Edwards) Statewide in the mountains, but always rare; vi; (r). Foodplant is lupine.

112. Glaucopsyche lygdamus oro (Sudder) Statewide in the mountains; iv-vii; (c). Feeds on Lupinus and Hedysarum in Utah and has been associated with ants.

113. Celastrina pseudargiolus (Boisduval & LeConte) Statewide in the mountains; iv-vi; (u). The subspecific status of Utah material is as yet undetermined.

Family NYMPHALIDAE

Subfamily APATURINAE

114. Asterocampa celtis (Boisduval & LeConte) 13; vi; (u).

115. Asterocampa leilia (Edwards) 20, (Washington Co); vi; (u).

Subfamily LIMENITIDINAE

116. Limenitis weidemeyerii latifascia Perkins & Perkins 1, 2, 3, 4, 5, 8, 12, 17, 18; vi-viii; (c).

117. Limenitis archippus archippus (Cramer) 4, 8, 12; vi, viii; (r). 4, 8, 12; vi, viii; (r). This species occasionally strays into the State.

118. Limenitis bredowii eulalia Doubleday 13, 18, 19, 20; vi; (u).

Subfamily VANESSINAE

119. Vanessa atalanta (Linnaeus) 4, 5, 20; vi-viii; (u). Double brooded.

120. Vanessa virginiensis (Drury) 8; vi; (r). Single record for the State; South Fork of the Provo River, Summit Co. Probably more widespread.

121. Vanessa cardui (Linnaeus) Statewide; multiple brooded. v-ix; (c).

122. Vanessa carye Hubner Statewide in the mountains, vi-ix; (c).

Subfamily NYMPHALINAE

123. Nymphalis californica (Boisduval) 4, 8; vii-viii; (r).
124. Nymphalis milberti furcillata (Say) Statewide in the mountains vi-ix; (c).
125. Nymphalis antiopa (Linnaeus) Statewide in the mountains, v-ix; double brooded; (c).
126. Polygonia satyrus satyrus (Edwards) 1, 2, 4, 5, 8, 15; vi, viii, double brooded; (u). Polygonia in Utah are quite variable and need much further study.
127. Polygonia hylas (Edwards) 2, 4; vi; viii; (u).
128. Polygonia zephyrus (Edwards) 4, 5, 8, 13, 16, 17; vi, viii; (c).

Subfamily MELITAEINAE

129. Chlosyne lacinia crocale (Edwards) 19; ix; (c). In Utah, two forms are recognized; C.l. rufecens (Cockerell) and nigrescens (Cockerell).
130. Chlosyne damoetas (Skinner) 9; viii; (u).
131. Chlosyne gorgone carlota (Reakirt) 4; vi; (u). This species is found along the Jordan river in Salt Lake County, 4800'.
132. Chlosyne flavula (Barnes & Mcdunnough) 4; vi; always montane. In some localities is sympatric with acastus.
133. Chlosyne acastus (Edwards) Statewide to 8000'. v, viii; (u). For most of the State the species is double brooded. However, in (20) a third brood has been reported in ix.
134. Chlosyne neumoegeni (Skinner) 18; iii-iv; (r).
135. Thessalia alma (Strecker) 5, 6; v; (u).
136. Poladryas arachne arachne (Edwards) 15, 20; vi; (u).
137. Phyciodes tharos pascoensis Wright Statewide in the mountains to 9000'; vi-vii; (c).
138a. Phyciodes mylitta mylitta (Edwards) Statewide in the mountains; iv-v, viii-ix; double brooded; (c).
138b. Phyciodes pallida barnesi Skinner 4, 5, 8; vi; (u). barnesi is somewhat larger than mylitta and frequents sagebrush in the mentioned areas. In many cases they are sympatric.
139. Phyciodes campestris camillus Edwards Statewide, vi-viii; at least two broods; (c).
140a. Euphydryas anicia maria (Skinner) 3, 4, 8; vi-viii; (u) local.
140b. Euphydryas anicia alena Barnes & Benjamin 12, 13, 17, 20; v; (c) local. Principally in the Colorado River drainage.
140c. Euphydryas anicia euryton (Mead) 8; vi-vii; (u) local. Uintah County only.
140d. Euphydryas anicia wheeleri (H. Edwards) 5, 6, 16; vi; (u). Found mainly in the Basin & Range Province.
141. Euphydryas colon (Edwards) 1; vi; (r). Known only from Clear Creek, 7500'.
142. Euphydryas editha ssp. 15; vi; (u). A single record; Grassy Trail Creek Carbon Co..

Subfamily ARGYNNINAE

143. Boloria selene tollandensis (Barnes & Benjamin) 2; vi; (u) local.
144. Boloria kriemhild (Strecker) 4, 8, 15: vi-vii; (c).
145. Boloria freija browni (Higgins) 2, 8; vi; (u) local.
146. Boloria titania helena (Edwards) 8; viii; (r).
147a. Speyeria nokomis nokomis (Edwards) 8, Uintah County only, 5600'; viii; (u) local.
147b. Speyeria nokomis apacheana (Skinner) 17, 18, 20; viii; (u).
148. Speyeria coronis snyderi (Skinner) 2, 4, 5, 8, 15, 16, 20; vii-viii; (c).

149a. Speyeria zerene platina (Skinner) 2, 4, 5, 7, 8, 10; vii-viii; (c).
149b. Speyeria zerene cynna dos Passos & Gray 1, 7; vii-viii; (c).
150a. Speyeria callippe harmonia dos Passos & Gray 1, 2, 4, 5, 7, 8, 15, 16; vi- viii; (u).
150b. Speyeria callippe nr. gallatini (Mcdunnough) 10; vii; (c).
151a. Speyeria egleis utahensis (Skinner) 2, 4, 8, 15, 16; early vi-vii; (c).
151b. Speyeria egleis linda (dos Passos & Gray) 1, 4, 5; late vi-vii; (u).
152a. Speyeria atlantis wasatchia dos Passos & Gray 1, 4, 8, 15; vii-viii; (c).
152b. Speyeria atlantis chitone (Edwards) 17, 18, 20; vii-viii; (u).
152c. Speyeria atlantis nikias (Ehrmann) 12, 13; vii-viii; (u)
152d. Speyeria atlantis tetonia dos Passos & gray 5: vii-viii; (u).
153. Speyeria hydaspe sakuntala (Skinner) 2; vii-viii; (r).
154. Speyeria mormonia mormonia (Boisduval) 1, 2, 4, 8, 15, 17; vii-ix; (c).
155a. Speyeria cybele carpenterii (Edwards) 12; vii-viii; (c).
155b. Speyeria cybele letona dos Passos & Gray 2, 4, 5, 8, 15; vii-viii; (c). Females are quite rare.
156. Speyeria aphrodite ethene (Hemming) 2; vii; (d). Although Gray (1947) lists Utah within the range of the species, I have not seen any records to confirm it. If it does occur, it would be in Cache County.
157. Euptoieta claudia (Cramer) 8, 11, 18, 20; vi, viii; could be double brooded; (u).

Family DANAIDAE

Subfamily DANAIDAE
158. Daunus plexippus (Linneaus) Statewide viii; (c).
159. Daunus gilippus strigosus (Bates) 5, 19; viii; (r).

Family SATYRIDAE
Subfamily SATYRIDAE
160. Euptychia dorothea (Nabokov) 12, 20; vi, viii; double brooded; (r).
161. Euptychia henshawi Edwards 16, 18; vi; (u).
162. Coenonympha ampelos elko Edwards 2, 4, 4500'; vi, viii; double brooded; (c).
163. Coenonympha ochracea ochracea Edwards Statewide in the mountains 5000' - 8000'; vi-vii; (c).
164. Neominois ridingsii stretchii (Edwards) 10, 14, 15, 20; vi-vii; (u) local.
165. Cercyonis pegala ariane (Boisduval) 2, 4; 4500'; vii; (u). Among Utah specimens, the female forms stephensi (Wright) is quite common.
166. Cercyonis meadii mexicana (Chermock) 20; vii-viii; (u).
167. Cercyonis sthenele masoni (Cross) 4, 6, 7, 10, 11, 13; vii; (c).
168. Cercyonis oetus charon (Edwards) Statewide in the mountains; vii-viii; (c).
169. Oeneis chryxus chryxus (Doubleday) 4, 7, 8, 15; vi-viii; (u).
170. Oeneis jutta reducta Mcdunnough 8; vi-vii; (r). This species is most common in the upper Bear River drainage, Uintah Mountains, in odd numbered years.
171. Oeneis taygete edwardsi dos Passos 9; viii; (r).
172. Oeneis melissa lucilla Barnes & McDunnough 9; viii; (r).
173. Erebia episodea episodea Butler 12; vi; (u) local.
174. Erebia magdalena magdalena Strecker 9; viii; (r).
175. Erebia callias Edwards 9; vii-viii; (u)

Journal of Research on the Lepidoptera 10(3):203-214, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

NOTES ON DESCRIBING, MEASURING, PRESERVING AND PHOTOGRAPHING THE EGGS OF LEPIDOPTERA

NOEL McFARLAND
P. O. Box 475, Geraldton, Western Australia 6530

Note: Any figure numbers mentioned in this paper refer to egg photographs in the paper that follows (p. 215).

Describing Eggs

In the study of (any) lepidopterous eggs, some important differences to look for, and always worth recording in the notebook, are listed below:

(1) Details on the *chosen site(s) for oviposition* under natural conditions. If this information is not available, it is often possible to speculate on it, often with a fair degree of accuracy, by observing where and how a captive female places her eggs during confinement. What type of surface appears to be most acceptable—smooth or rough? Are the eggs deposited exposed, in the open, or in crevices or otherwise hidden locations? What type of ovipositor does the female have?

(2) *The mode or pattern of oviposition.* In captivity, this often provides further clues concerning the above. The mode of oviposition is often (not always) consistent among related species, but can show wide variation at the subgeneric or generic level. Are the eggs dropped free (in no way adhering to anything), or are they attached to a substrate? If attached, note color (if any) and strength of the adhesive (securely vs. weakly-glued). In what pattern and alignment are they deposited: Singly; in two's and three's; in short or long, curving or straight rows (end-to-end or side-to-side); in flat (single-, double-, or multiple-layer) masses, or heaped-up masses; in piles or clusters; in stacks; or in any other formations, which may be regular or ir-

regular? Are they deposited end-up, or on their sides? Is each egg touching or overlapping the next, or are all distinctly separated? If touching, are they also *adhering* to each other as well? All aligned in the same direction, or variable in alignment?

(3) *The covering, if any.* Naked versus coated (or partially-coated) with deciduous, hair-like (or fluffy) scales from the end of the female's abdomen, or with some other substance (*i.e.,* a dried frothy or foam-like covering; soil particles, etc.).

(4) *The basic shape* or outline of the egg, and its various profiles when viewed from different positions.

(5) *The relative hardness,* softness, or flexibility of the chorion (= shell). This can vary tremendously.

(6) The type (and extent) of *surface sculpturing* on the shell, such as ribs, grooves, pits, granulations, or pustules, etc.

(7) *Degree of luster* or surface-shine (gloss or sheen); some (relatively few) eggs show little or no luster. Whatever the case, this is an important feature.

(8) *Transparent* and/or *translucent* versus completely *opaque* shells.

(9) *ALL color changes* that are observed during the incubation period, and any variations noted in these color changes. Exceptions: If the shell is completely opaque, no color change will be seen (as in many anthelids, saturniids, or lasiocampids, and in some notodontids and thaumetopoeids, etc.).

(10) *Measurements* of all dimensions should be recorded. These are valuable for comparison with the egg dimensions of related species already known.

(11) A statement as to whether the egg appears *large or small for the size of the adult female.* The decision as to whether a species deposits a "large" or "small" egg cannot always be made, but it is very often instantly apparent, provided that the observer has already had a fair range of experience with lepidopterous eggs. The reasons I consider this concept to be of value are discussed in the fourth paragraph of the second paper following this one.

(12) The *hour of larval emergence,* and through which region of the egg (side, top, or end)? Is the exit-hole clean-cut and perfect, or rough and irregular?

(13) After larval emergence from the egg, is the *shell devoured* —entirely, partially, or not at all?

When comparing lepidopterous eggs, it is important to consider *all* of the above points—not just the surface morphology, color changes, and measurements. By recording all of these points (plus any others that family or generic specialization may disclose to be important), it is frequently possible to glean some very nice separations for closely-related species, without obligatory reference to micropylar detail or S.E.M. microphotography. Knowledge of this fact could be of considerable moral support to isolated field workers or amateurs, possessing only a hand lens or modest microscope, but having, nevertheless, an abundance of enthusiasm and sharp powers of observation. (See Wheeler, 1939). Some workers in this category have much to offer, but will eventually die, publishing nothing, for fear of not "measuring up" to the more sophisticated productions of present day professional entomology. These losses are *everyone's*. In some instances the losses will be irreversible, as more and more unique habitats are destroyed (worldwide), and the *few* who really knew these localities die with them—*publishing nothing.*

Measuring and Comparing Eggs

A convenient and consistent method for expressing, recording, and comparing the measurements of "Macro" eggs is presented here. Refinements are included by means of which it is possible to express all observed variations in the egg dimensions of a single species, and to infer *which* (of all measurements shown) is the most typical noted for each dimension (based on the series measured). I have evolved this method over the past 5 years, while rearing about 180 "Macro" species from the egg in South Australia, and feel that it could now be presented for consideration by others doing similar work, who might find in it a consistent and workable system. It is *not* recommended as a method for measuring the eggs of smaller "Micros", but is very satisfactory for most "Macro" eggs. Finer measurements and equipment are needed for the former.

This system can be employed by field workers anywhere, requiring only one precision instrument—*metric dial calipers, accurate to 0.05 mm.* (1/20 mm.). The Japanese "Peacock" brand is one of several available in Australia (price was approx. $24.00 in 1967). A good hand lens, used to make certain of accurate positioning of the egg during all measurements, is a necessity, at least for the smaller "Macro" eggs. The reading can be considered correct when the calipers are *just* able to pick up (and hold) the egg securely, but *without* denting its

shell. (The minutest release-turn of the dial should drop the egg.) Avoidance of dried adhesive, or other foreign material on the surface, must be kept in mind when measuring eggs that were heavily-glued or scale-coated, etc. An attempt should always be made to obtain and measure a *series* of eggs from one or more females, watching for variation in size or shape.

Metric dial calipers are available in various brands and calibrations, some calibrated finer than 0.05 mm., but smaller measurements do not appear to be required (or even desirable) among *most* of the "Macro" eggs I have studied to date. Measurements finer than 0.05 mm. can become quite meaningless, and often serve only to cloud or needlessly complicate the picture, due to the considerable variation in size which can be encountered among the eggs from a single female.

Size variation, among the eggs from a *single* female, *commonly* falls in the range of 0.05 to 0.10. The eggs of a larger South Australian oenochromine geometrid, *Monoctenia falernaria* Gn., have been observed to vary by as much as (up to) 0.55 mm., in one of the dimensions (maximum length), within a series obtained from *one* female (Blackwood, S.A.)! (See Fig. 28 and commentary, in the paper that follows). Such considerable variation as this is apparent even to the unaided eye. Sometimes the shapes or proportions of eggs vary to a certain extent; this also applies in the case of *M. falernaria.* There is often a nice separation in egg size between some of the species in a genus; conversely, there can also be considerable or complete overlap at the extreme measurements recorded, especially when egg size variation is great within a species, as in the case of *M. falernaria.* (Compare the measurements of *M. smerintharia,* Fig. 27, with those of *M. falernaria;* those of the latter entirely encompass those of the less variable *M. smerintharia* egg).

After *M. falernaria,* the most variation in egg measurements (among South Australian moths reared to date), has been recorded for the following four species: Notodontidae—*Danima banksiae* Lew. (0.45 mm. maximum variation in diameter, between two widely-separated populations); Geometridae, Ennominae—*Thalainodes macfarlandi* Wilson (up to 0.30 mm. variation in length), *Cleora bitaeniaria* (Le Guill.) (0.20 mm. maximum variation in length); Anthelidae, Munychryiinae—*Munychryia senicula* Walker (0.20 mm. maximum variation in length). The complete measurements for the egg of *M. senicula* (from Highbury, South Australia) are: 1.40-*1.35*-*1.30*-1.20 x

1.10-*1.0*-0.95 x 0.95-*0.85*-0.80 mm. For photographs of the egg (and other stages) of *M. senicula*, see Common and McFarland (1970).

Egg shapes can be reflected (and thus automatically compared) by the manner, and the sequence, in which the measurements of their various dimensions are set down. (It seems advisable to do away with such terms as "length", "width", "height", or "diameter", which cannot always be rendered analogous). This system involves recording of *all* dimensions of the egg in a sequence of DIMINISHING MAXIMUMS. (See numerous examples in next paper). At the same time, it is possible to include the complete range of variation observed for each of the dimensions (based on a series measured); it can also be indicated which measurement, within each dimension, is the more usual or "normal", if this information is possible to glean from the available eggs.

In order to explain what is meant by "diminishing maximums", it is first necessary to briefly describe six basic egg shapes commonly encountered among "macro" moths: (1) Spherical eggs, having only *one* consistently measurable dimension; (2) nearly spherical eggs, having *two* slightly differing dimensions, such as those of the geometrids *Phallaria ophuisaria* Gn. (Fig. 29), *Idiodes apicata* Gn. (Fig. 31), or *Amelora leucaniata* Gn., etc.; (3) more-or-less hemispherical eggs, having *two* differing dimensions, as in many notodontoids and noctuoids (Figs. 10, 11, 12, 14, etc.); (4) cylindrical or subcylindrical eggs, having *two* very contrastingly different dimensions, as typified by the geometrids *Rhynchopsota rhyncophora* (Lower) (Fig. 30), *Stibaroma melanotoxa* Guest (Fig. 32), *Cleora bitaeniaria* (LeGuill.) (Fig. 33), and numerous other moths; (5) more-or-less losenge-shaped eggs, having *three* clearly measurable maximum dimensions, as typified by many of the Geometrinae (Fig. 23) and Ennominae; (6) eggs still having *three* clear-cut maximum dimensions, but *tapering* notably toward the smaller end, as typified by the ennomine geometrids *Mnesampela fucata* (Feld.) (Fig. 35), *Niceteria macrocosma* (Lower) (Fig. 40), *Stathmorrhopa macroptila* Turner, and some of the Geometrinae.

Taking, as an example, a series of spherical or near-spherical eggs, a number of them are measured, making a special effort to include all eggs appearing to be slightly larger or smaller than the majority, as well as whatever appear to be typical sizes and shapes in the available series. If any variation is found,

it can be expressed as follows: "Size = 1.30-*1.25*-1.20 mm.". This implies that the (maximum) diameter recorded, for the largest egg(s) in the series measured, was 1.30 mm.; that the (maximum) diameter recorded for the *smallest* egg(s) in the series measured, was 1.20 mm.; that 1.25 mm. (italicized) was the maximum diameter recorded for the *majority* of eggs in the series measured. If the variation in size was found to be about equally divided among the eggs measured, it would be recorded simply as: "Size = 1.30-1.20 mm.". (The insertion of the "*1.25*" is a refinement in interpretation, not worth including unless an adequate series has been measured, and the majority clearly fall between the two extremes). This italicized measurement (if included) should not always be interpreted as the average; see examples in Figs. 32, 33 and 38 of the paper that follows (last line under each commentary). In Fig. 33, a number of eggs measured in one series (Blackwood S.A.) varied from 1.25 down to 1.05 mm. in max. length, but by far the majority were found to have a max. length of 1.20 mm., or very close to it. Thus, *1.20* is italicized (or underlined) as the "typical" length for eggs of the Blackwood population of that species.

Taking eggs having two dimensions, Figs. 10-20 provide good examples. Looking at Fig. 12, the dimensions are 0.90-*0.85*-0.80 x *0.75*-0.70 mm., recorded in a sequence of diminishing maximums. The first set of measurements (preceding the "x") refers to the (maximum) diameter in this case, the most common diameter in the series measured being 0.85 mm., or close to it; the second set of measurements (following the "x") refers to the height in this case, the most common maximum height in the series measured being 0.75 mm. Looking at Fig. 13, the dimensions recorded are 1.25-1.20 x 1.00-0.85 mm. The first set of measurements (1.25-1.20) refers to the maximum length in this case, which was observed to vary by 0.05 mm. in the series measured; the second set refers to the diamet¬r in this case, which is seen to vary to a greater extent (0.15 mm.) than the length. Comparing the (complete) measurements of Fig. 12 with those of Fig. 13, it can be seen that these represent two very different egg shapes; the corresponding photographs depict this obvious difference in proportions. Fig. 14 shows an egg with its two dimensions almost identical, but its diameter is usually a little greater than its height. Fig. 18 is an example showing little or no variation (to 0.05 mm.) in either of its two dimensions (thus, recorded simply as 0.70 x 0.60 mm.);

in this case minor variation might be expected to show at measurements *finer* than 0.05 mm. Yet, in contrast with many geometrid eggs, these of the arctiid, *Nyctemera,* are notably uniform in their dimensions.

Taking an example from eggs having three dimensions (length x width x height), Fig. 35 is chosen for discussion because of the fact that this egg tapers from thick at one end to much smaller at the other. When height, width, or diameter decline from one end of an egg to the other, it should be the *maximums* (of all dimensions) that are measured and recorded. (The tapering height of many geometrine eggs represents a less extreme example, often declining very slightly from one end to the other).

To summarize this system of diminishing (or decreasing) maximums: Variations in egg dimensions are uniformly recorded; all dimensions and measurements are arranged in a continuous sequence, from maximums of the largest to maximums of the smallest eggs in the series measured; all recorded measurements imply *only* the maximums for each egg measured in a given series; variations (in the maximums) of one dimension are separated from each other by hyphens; any second or third (new) dimension is separated by an "x" from any preceding it. Some reasons to recommend this system are as follows: It permits arrangement, of all recorded measurements for all dimensions, into a neat gradient series without any interruptions (or transpositions) in the flow. Where overlap between two dimensions occurs, this is instantly apparent, without the need to shuffle figures. In most cases a fairly accurate image of the egg proportions can be visualized while reading the measurements. (Before looking at the photos, compare the measurements for Figs. 7 and 8, trying to imagine how they will differ in shape). Any need for the inclusion of words (sometime ambiguous), such as "length", "width", "diameter", or "height", is eliminated. Both the recording and the comparing of egg dimensions are simplified, while increasing the amount of information conveyed.

A system of *increasing* maximums (equivalent to any of my measurements if recorded entirely in reverse, from right to left) could be used in the same way. However, the sequence of *diminishing* maximums seems to lend itself more naturally to the process of recording egg measurements.

Dry Preservation of Eggs and Larval Exuviae

Empty (hatched) egg shells (or fragments thereof) are well worth saving, if not too badly collapsed or devoured. They

are always valuable as comparative material in a life history collection, or for future study and photography. They show surface features better than alcoholic material, when held under the right type of lighting. There is never any swelling, as is sometimes the case with eggs in fluid preservatives. Accurate measurements can be obtained from empty shells, if they are not too flimsy, or partially eaten. The dry shells often convey information about the mode of attachment (singly or otherwise), location of larval exit-hole, whether or not the shells were partially consumed, and so on.

Empty egg shells are quite adaptable to certain photographic techniques, including S.E.M. (see Figs. 41-48 in the paper that follows); they may be preferable for the latter, because they are already dry, and (usually) relatively clean. If not sufficiently clean, they are quickly and easily cleaned in most cases. The shells can be stored in *small*, clean, dry glass tubes or vials, into which should be inserted labels tying them to the corresponding adults and larvae. The labels should fit tightly inside the tubes so that there is no label movement if the tube is shaken; this prevents damage to delicate or flimsy egg shells if the tubes are mailed or roughly handled. They may be left as attached to leaf pieces or bits of twig, if these are thoroughly dried prior to closing the tubes. If the eggs were attached to plastic bags, paper, or muslin, this is easily cut down to fit into the tubes. The tubes (and contents) must be thoroughly dry when closed, or mould will rapidly develop. Store in a cool, dark, *dry* place.

A very worthwhile addition to the dry eggshell collection (whenever numbers permit), is to kill a few of the young larvae while still in their eggs, *just before hatching*, by placing the eggs in a freezer for several days. This must be done *before* they have started chewing through the shells, the object being to obtain dry egg specimens with entirely perfect surfaces and no collapse. They should be as close to hatching as possible, which usually insures that no collapse of shells will take place after the larvae inside have been killed. (Controlled heating in an oven might also prove to be a successful technique). Dry egg specimens obtained by freeze-killing the larvae are superior to hatched shells because of the completely undamaged chorion and the increased rigidity, making them easier to handle during measurement or preparation for photography, etc. If only a few eggs are obtained from a confined female, it may not be advisable to kill any larvae still in the eggs, if one also hopes to pre-

serve specimens of all larval instars, pupae, and adults from the same eggs. It is in such cases that the hatched egg shells are most valuable to save, when otherwise no dry egg specimens would be preserved in *any* form. Unfortunately, the micropylar area is often partially damaged or completely destroyed during larval emergence from the egg, although the hatched shells of some species, such as the Australian ennomine geometrid, *Idiodes apicata* Gn., may show the micropyle intact (see Figs. 46-47 of the paper that follows).

It is often convenient to keep early instar exuviae in the same tube with the dry egg shells; they will not damage each other. If no larvae have been preserved in the first instar, these cast skins and head capsules become particularly important to save. Second instar head capsules and cast skins can also be enclosed in the same tubes with the dry egg shells. Exuviae of any subsequent (larger) instars, if saved dry, are better kept in other tubes separate from the egg shells.

Uncomplicated Egg Photography

In the introductory section of the paper that follows, the camera and microscope set-up used (for Figs. 1-40) is briefly described. Additional details are included below, to cover some of the techniques that were used to obtain these photographs.

Lighting: I have found bright morning sunlight preferable to electronic flash for egg photos of this nature, because it is easier to achieve an entirely predictable modelling (three-dimensional effect) with the sunlight. The eggs can be carefully scrutinized (through the camera which is attached to the microscope), and their positions can be minutely adjusted until exactly the desired effect is obtained, with reference to light and shadow on surface-sculpturing or pits, etc., so as to bring out any such details through the intentional (but moderate) use of shadow. Shadow should never be entirely eliminated from egg (or pupal) photos such as these. Flash tends to penetrate too uniformly and completely into small grooves and pits, etc., often flooding them out or rendering them more-or-less obscure. *Low-positioning* of the flash head, coupled with the use of reflectors ("bounce") can, of course, eliminate this to some degree. Yet, it is still sunlight that best allows one to study the photo at leisure, and then to photograph *exactly what was seen,* once all adjustments have been made to the photographer's satisfaction. Morning sun, coming in through an open (or very clean if closed) window, is almost always

quite suitable for this type of photography, *provided* the sky is brilliant and clear; under hazy, smoggy, or cloudy conditions, such lighting is not as suitable. Brilliant artificial light sources then become preferable.

In photos such as these, it is most important to capture surface shine at its full value; however brilliant it may be, it must not be eliminated or reduced. Shine or gloss on the chorion surface often varies greatly between the eggs of different species, and is therefore a most useful taxonomic aid to characterizing any lepidopterous egg. In the paper that follows, the relative amount of surface-shine is consistently reproduced for each egg depicted (appearing as highlights or variable white areas on the eggs); it can be seen to vary from brilliant surface shine (Figs. 9, 14, 24, and 25, etc.), to moderate or slight sheen (Figs. 7, 26, 30, and 40, etc.), to little or no sheen (Figs. 8, 10). Surface texture usually determines the degree of shine; generally, the smoother the surface the more shine.

Exposure-time for Figs. 1-40 were mostly in the range of 1/15 to 1/2 second, with the majority being 1/8 or 1/4-second exposures. B. & W. films of slower speeds were used: ASA 20, 32, and 50 (mostly ASA 32). Faster films are also excellent for such photos, if of very fine grain. The selection of film depends, to a large extent, on the type of lighting preferred and the results desired.

Backgrounds chosen are of utmost importance to the whole picture. If the eggs are removed from the substrate to which they are attached, they should first be carefully cleaned, by removing any adhering scales or other particles (dust, etc.). A series may then be placed on a selected background, and positioned so as to show all major profiles. Of materials available in Australia, I have found small squares of "Perspex" (acrylic sheet plastic, ± 1/8-inch thick) to be superb egg (or pupal) backgrounds. Perspex is available in numerous colors, and is mostly *translucent,* sometimes transparent. Being translucent, it "absorbs" shadows (greatly softens them), and the eggs may be set down directly upon the plastic surface. If static develops, causing the eggs to jump erratically about when being positioned, this trouble is easily overcome by rubbing the Perspex plate with an anti-static cloth before attempting to use it.

It is convenient to have on hand several colors of Perspex, cut into small plates (1-inch to 2-inch squares). The most useful colors to have are translucent milky-white ("Opal"

Perspex), translucent gray-white, translucent (but *not* transparent) pale blue and pale gray, water-clear (colorless and transparent), transparent deep purple, and jet black. It is also highly desirable to sand some of these small plates (on *one* side), with very fine Emory paper, using a gentle rotary motion. These sanded plates will have a matte finish (no shine), which is desirable in many photos, but the shadow-absorbing power of the Perspex will be somewhat reduced. The various clear plates can also be stacked upon one another to achieve subtle variations in background effect. With a set of small plates including *all* of the above colors (plus any others, as requirements dictate), good results can be obtained with eggs of almost any opacity or color. These small plates are of great value because they may be slowly turned, without disturbing the arrangement of eggs on them, in order to obtain the best positioning with relation to light source (for maximum surface definition, or highlights in shiny areas, etc.). If the eggs are left attached to the original substrate, the choice of background is usually less important. Shadows will often be darker and may cause trouble. Different lighting (source and/or direction, plus use of flash "bounce", etc.) can overcome these problems. For most egg photographs, it is desirable to remove at least a few of the eggs from the original substrate, unless one desires to first depict the mode of oviposition, undisturbed (Figs. 17, 18, and 19, for example); *both* types of photos have their values.

If moths can be induced to oviposit inside thin, colorless polyethylene bags, as earlier recommended by Peterson, the eggs are most easily handled and photographed. It was by this method that I obtained Fig. 4; it would not have been possible to remove them from the substrate without damage, so it was necessary that they be deposited on a flat and transparent surface in order to get photos from beneath, and also in order to be free to make use of whatever background might be required.

I have described the above techniques to demonstrate some ways that good results can be obtained in any location, often with the simplest of equipment. There should be no compromise with the quality of the camera, lenses, or microscope, however, which should be the *best* the worker can obtain. Beyond this, it is *not* necessary to have access to a laboratory full of elaborate, expensive equipment in order to produce good photographs; all can be done at home, on a good solid table, using various small props and gadgets made from wood, plastic, and scraps

of metal, etc. There are few limitations in this sphere, aside from the time available for the work, or the worker's imagination. (See Karp, 1966—a *most* valuable reference).

The more conventional insect egg photographs, at lower magnifications (less than 100x), as in Figs. 1-40 of the paper that follows, or after Peterson (1960-63), have great value as taxonomic aids. Yet, when photographs like these are compared with those taken by more recently-developed scanning electron microscope techniques (for example, Figs. 41-48 of the paper that follows), they are seen to be rather elemental!

My object here is not to dwell upon this undeniable fact; rather, to suggest that it is still of great importance for workers to *continue* producing (and publishing) egg photos at lower magnifications. The primary reason for this statement is that there always will be a need to bridge the huge gap which exists between the field (what is seen with the naked eye, or, at best, with a hand lens)—and the lab (what can be produced by S.E.M. techniques). Somewhere in between these two extremes, it is possible to compare or relate the photograph in *either* direction—back to what was seen with the naked eye (or a hand lens), OR up to what will be produced by the S.E.M. It would be a great mistake to drop this stepping-stone from all future illustrations of insect eggs. As "the field" *still* remains our source of all new material (and of inspiration, in many cases), the implications of the above should be abundantly apparent!

REFERENCES

COMMON, I. F. B. and N. McFARLAND (1970): A New Subfamily for *Munychryia* Walker and *Gephyroneura* Turner (Lepid. - Anthelidae) and the Description of a New Species from Western Australia. *J. Australian Ent. Soc.* 9: 11-22.

DORING, E. (1955): Zur Morphologie der Schmetterlingseier. Berlin. (Contains hundreds of detailed drawings of the eggs of European "Macrolepidoptera").

KARP, T. (1966): "Super Close-ups with your SLR." (single-lens reflex). *Modern Photography*: Feb., 1966.

MacKAY, M. R. (1966): An editorial. *Canad. Ent.* 98(8): 785-788.

——— (1968): About Lepidopterous Immatures. *Canad. Ent.* 100(4): 337-341.

PETERSON, A. (1960): Photographing Eggs of Insects. *Florida Entomologist* 43(1): 1-7. See also Vol. 44(3): 107-114; 45(2): 81-87; 45(3): 109-119; 46(2): 169-182 (all same author, same journal).

WHEELER, W. M. (139): Essays in Philosophical Biology, pp. 117-142. Harvard Univ. Press, Cambridge. 261 pp.

WILSON, J. O. (1972): A New Species of *Thalainodes* (Lepidoptera: Geometridae—Ennominae) from Central Australia. *Mem. National Mus. Victoria* 33: 123-124.

Journal of Research on the Lepidoptera 10(3):215-247, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

EGG PHOTOGRAPHS DEPICTING 40 SPECIES OF SOUTHERN AUSTRALIAN MOTHS

NOEL McFARLAND

P. O. Box 475, Geraldton, Western Australia 6530

INTRODUCTION

THE 48 FIGURES IN THIS PAPER were selected primarily to show some of the *diversity in egg form and mode of deposition* among different families of "Macro" moths (Figs. 1-20), and to illustrate this yet again for a single family, the Geometridae (Figs. 21-48). Most of these eggs were obtained from captive moths, using techniques described in earlier papers (McFarland 1964, 1965). All species depicted here are represented by identically code-numbered preserved eggs, larvae, and pupae in alcohol, empty (dry) egg shells, cocoons (on pins), associated adults, and occasional parasites, all of which are deposited in the Entomology Dept. of the South Australian Museum, North Terrace, Adelaide, South Australia 5000. The (McFarland) code-number for each species appears at the beginning of each commentary, opposite the name of the species. The egg measurements are given at the end of each commentary (where available), in *diminishing maximums,* as discussed at length in the preceding paper. For accuracy, only the recorded measurements should be compared; the sizes of the eggs in different photographs do not always reflect their sizes *relative* to each other. With the exception of Figs. 41-48, all photographs are by the author, and all show unhatched *living* eggs. Figs 1-40 were taken on 35mm. black-and-white film (various brands and speeds), using the Japanese (S.L.R.) Topcon RE. Super camera, with through-the-lens light metering. The camera body (minus lens) was attached (by a specially-adapted tube) to the Japanese Nikon SMZ-2 binocular microscope with zoom lens. In all cases *bright morning sunlight* was used as the (only) light source; details of this photographic technique are given in the preceding paper.

LOCALITIES: Most of the adult females confined for eggs were attracted to one 15-watt unfiltered ultraviolet light (the "black light", G.E.F15T8.BL), in a garden at 2 Gulfview Road, BLACKWOOD, SOUTH AUSTRALIA (836 feet elevation), in the foothills of the Mount Lofty Range, about 7 miles south of Adelaide, where I was living from Jan. 1965 to Sept. 1970. All eggs illustrated (except Fig. 9) represent species occurring within a short distance of the city of Adelaide. Many of these species, or close relatives, are known also from other parts of southeastern Australia (Victoria, Tasmania, New South Wales, and southern Queensland), and from the southwest of Western Australia in several cases. The exact locality is given, for all eggs illustrated, at the beginning of each commentary, along with the recorded months of adult occurrence *in that locality.*

As a matter of interest to readers in other countries, the four seasons in South Australia can be interpreted as follows: SEP.-NOV. = *SPRING* (cool to warm; wet grading to dry); DEC.-mid MAR. = *SUMMER* (cool to hot; mostly *dry*); late MAR.-mid MAY = *AUTUMN* (warm to cold; dry grading to wet); late MAY-AUG. = *WINTER* (mild to cold; mostly *wet*). October in coastal South Australia (near Adelaide), or in the south of Western Australia (near Perth), corresponds roughly to April in coastal California south of San Francisco. The climate approximates the (coastal) Mediterranean type, with a cool wet season and a (mostly) warm to hot dry season. *Average annual rainfall* (based on 41 years of records, 1929-1969) is 26.75 inches (2675 points) at Blackwood, South Australia, where most of the illustrated species occur. Annual precipitation as high as 38 inches (1968) and as low as 14 inches (1967), has been recorded during this 41 year period (records in the Blackwood Post Office). Snow never falls here, except for traces (once or twice each winter), only in the Mt. Lofty summit area. *Temperatures:* Diurnal summer highs rarely surpass 102°F. in the Blackwood vicinity (usually in the 70's, 80's or low 90's), and nocturnal winter lows rarely drop below 34-35°F.

The native plants of the Blackwood-Belair-Eden Hills district of the Mt. Lofty Range compose a variable forest-and-scrub mixture of sclerophyll trees, shrubs, dwarf shrubs, grasses, and annual herbaceous plants, etc. Of the larger spp., *Eucalyptus odorata* Behr. ex Schldl., *E. leucoxylon* FvM. (Myrtaceae), and *Acacia pycnantha* Benth. (Mimosaceae) predominate in the Gulfview Road locality. There is also an extensive

introduced (naturalized) element; many of these are highly aggressive "weeds" here, to the great detriment of the dwindling (smaller) native plants. Prime examples, in this locality, are the woody South African shrub, *Chrysanthemoides monilifera* (L.) T. Norl. (Asteraceae), various blackberries, *Rubus* spp. (Rosaceae), and the European olive (Oleaceae), among others. *Homo sapiens* will predictably wipe out most of the little that remains (of the smaller and unique native flora) in the Blackwood-Belair district during the next two or three decades, if *C. monilifera* does not finish the job first.

DATES: In the following commentaries, dates should be interpreted as follows: "early" = the 1st through the 10th of the month; "mid" = 11th through 20th; "late" = 21st through 31st. In a case reported as "late MAY-JULY", the implication is that I have records for *all periods through* the month of July (early-mid-late); if this were not so, it would state "late MAY-early JULY" or "late MAY-mid JULY". The first of the date-periods recorded (as "late MAY", in the above example) represents the beginning of the flight (my earliest records for adult occurrence in the locality named); the latter part (as *late* July, in the example) represents the apparent end of the flight, when the species has past its peak and only occasional (usually worn) specimens are being encountered. All Blackwood flight records are based on 5½ *consecutive* years of collecting and observation in that locality.

DETERMINATIONS: All determinations are based on the associated adults (those bearing McFarland code-numbers on blue labels). Most of these have been compared with the type specimens. Determinations are cited as follows: DSF = D. S. Fletcher and assistant, K. Brookes, British Museum (Nat. Hist.), London; IFC = I.F.B. Common, Div. of Entomology, C.S.I.R.O., Canberra; NBT = N. B. Tindale, formerly of the South Australian Museum, Adelaide; NM = Noel McFarland (when on the staff of the S.A. Museum.) Code-numbered duplicate *adult* specimens of most of these species have been donated to the Australian National Insect Collection (Canberra), and to the British Museum (N. H.), during the course of this study.

The 40 species illustrated here, along with about 180 additional species, most of which represent more-or-less complete life history studies (all or most stages preserved), are deposited in the South Australian Museum, North Terrace, Adelaide, and

are available for loan to qualified specialists. To facilitate handling, and to insure accuracy, they should always be asked for *by code-number.* An "index" booklet exists, arranged by family, listing the code-numbers (and names if known) for all species in the collection.[1] Most of the South Australian material is dated between JAN. 1965 and DEC. 1971. Identically code-numbered notes (often extensive), plus black-and-white photographs, accompany most of thc species. These notes and photos always emphasize features connected with the *living* insects—*whatever will be lost once they are killed*—such as color descritions based upon the living specimens, characteristics of the habitat, ecological relationships (parasites, etc.), cryptic forms and the significance of their coloration (resting positions of adults and larvae, etc.), displays or reactions to disturbance, and any other observed details of behavior.

FOODPLANTS: To save repetition (and space) it was decided to omit any mention of foodplants in this paper, as a detailed paper on foodplant records (many new) is now in preparation; this will cover all but one of the 40 species illustrated here, plus numerous other southern Australian moths.

---

[1] Copies of this booklet (up to date through Dec., 1970) are deposited at the Entomology Dept., South Australian Museum (Adelaide); the Entomology Dept., Los Angeles County Museum, c/- J. P. Donahue (California); the Zoology Dept., Univ. of Florida, c/- T. C. Emmel (Gainesville); the British Museum (Nat. Hist.) c/- D. S. Fletcher (London). The original copy, constantly being added to, is kept by the author.

COMMENTARIES ON THE PHOTOGRAPHS

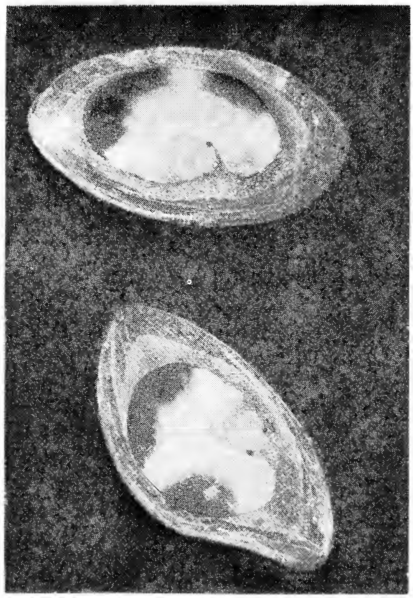
Figs. 1-20: Thirteen Non-geometroid Moth Families

Superfamily HEPIALOIDEA

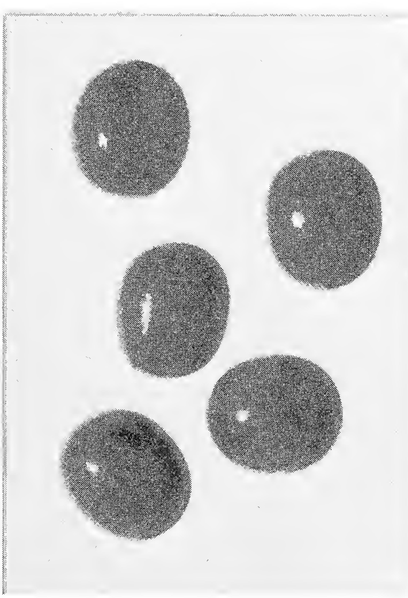
Family HEPIALIDAE

Fig. 1: *Aenetus blackburni* Lower (det. NBT) Hp.35(M) (Blackwood and Eden hills, South Australia; late MAR.-early APR. only). These eggs are scattered and dropped free by the female during oviposition (in no way attached). This is the typical mode of oviposition among the Hepialidae. Some hepialid eggs are more or less perfect spheres, and the shell is usually rather pliable and easily dented. When freshly deposited the eggs of this species are pure white, but they soon become opaque black. Considerable collapse of the shell took place

3



4



1

2

during development, but the young larvae hatched successfully. (This may be a normal occurrence during incubation?) Took 24 days to hatch (autumn).
Size = 0.75-0.70 mm. x ?

Spf. ZYGAENOIDEA

Fam. ZYGAENIDAE

Fig. 2: *Hestiochora rufiventris* (Walker) (det. DSF) Zy.8A (43 mi. W. of Eucla, Nullabor Plain, Western Australia; late NOV.-DEC. ±). As in many (perhaps all?) other zygaenoids, the eggs are notably soft-shelled (very easily dented or damaged). They are attached in long series up and down the small leaves and twigs of the foodplant, entirely naked and closely end-to-end, but rarely in actual contact. They are very obvious if present on the foodplant. Color, pale translucent yellowish. Took between 7-10 days to hatch (summer).

Size = *0.65*-0.60 x 0.55-*0.50* x 0.45-0.40 mm.

Fam. LIMACODIDAE

Fig. 3: *Doratifera oxleyi* (Newman) (det. IFC) Lm.5 (Blackwood, South Australia; mid MAR.-mid APR.; ♀ adult nocturnal, ♂ adult diurnal). The shells are very soft and easily broken; it is almost impossible to separate these delicate eggs without damaging them. They are extruded either in long chains, as shown, or in rounded masses of various sizes, lightly-coated with soft, pale brown "fluff" (scales) from the female abdomen. Heavily-laden females (probably recently finished mating) have a tendency to extrude their earliest eggs naked in long, straight or undulate chains, rather than ovipositing in masses. This is particularly evident among fresh females attracted to light, where they frequently extrude "egg chains" while sitting on the wall. Color translucent yellowish; surface shiny.

Fig. 4: *Pseudanapaea trigona* (Turner) (det. IFC) Lm.3 (Blackwood, South Australia; OCT.-mid MAY). The photograph shows two eggs, close to hatching, as seen from the underside. (They were deposited on a thin sheet of clear plastic, and photographed through it, over a dark background). The small larvae are clearly visible inside the colorless and transparent shells. The shells are exceedingly thin, pliable, and easily ruptured. In nature, they are attached singly to the foodplant leaves, appearing (at first) like tiny, clear, flattened

droplets of water, barely visible when viewed from above; later, they could be mistaken for *shiny* scales adhering to the leaves. When being deposited by the moth, they are so soft and flexible that individual eggs often have *entirely different shapes,* depending upon the angle of contact of the moth's abdomen with the substrate, and the pressure exerted, at the moment of oviposition! Thus, only "average" measurements of egg length and width can be made for this species. *Of all insect eggs I have seen to date, this species would seem the ideal subject for anyone wishing to study larval development as it takes place inside the egg.* (See also the sixth paragraph of the paper that follows).
Size (approx., max.) = 2.30 x 1.40 x 0.30 mm.

Spf. PYRALOIDEA
Fam. PYRALIDAE, Subfamily EPIPASCHIINAE

Fig. 5: *Epipaschia pyrastis* (Meyrick) (det. IFC) Py.31(M) (Blackwood, South Australia; NOV.-APR.). According to D. J. Carter, this species is under the genus *Macalla* in the British Mus. (N.H.). These eggs are very much flattened, soft-shelled, and "scale-like", with a finely-pitted surface, resulting in a sparkling surface shine. They are deposited in distinctive flattened masses, like shingles on a roof, each one partially overlapping two or three of those in front of it. The photograph shows only a part of one mass, as attached to the foodplant leaf.

Spf. BOMBYCOIDEA
Fam. LASIOCAMPIDAE

Fig. 6. *Digglesia rufescens* (Walker) (det. DSF) La.18 (Blackwood, South Australia; DEC.-FEB. and MAY-JULY). Typical of most bombycoid eggs, the shells are very tough and firm. The eggs are securely glued to the surface, in this case a piece of stiffened muslin, which is ideal for causing many moths to oviposit in captivity. The white areas of the shell are opaque. When the eggs hatch, the dark areas will appear transparent on the empty shells, and the opaque white markings will remain behind, exactly as seen in the photograph. The general appearance and maculation of these eggs is typical of many other lasiocampid eggs. A batch obtained 22 DEC. 66 (summer) took 10 days to hatch; a batch obtained in early JULY 66 (mid winter) took 28 days to hatch. (Both batches were kept indoors, but at approximately the natural temperatures of the habitat, including day-night fluctuations).
Size = 1.60 x 1.30 mm.

Fam. ANTHELIDAE

Fig. 7: *Pterolocera* sp. (det. IFC) An.2A
(10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia; mid MAR.-MAY). These eggs are very tightly glued to each other, wherever they contact along their sides. See the dried rings of colorless adhesive remaining attached on two eggs that have been broken off the main mass (upper right). The shells are opaque grayish-*brown* and very tough. This species occurs in brushy scrub, heath, or woodland areas, away from the immediate sea coast around Adelaide, and on Kangaroo Island. A closely-related species in the southwest of Western Australia (my An.10), has eggs quite different in coloration at the large end, although similar to these in general appearance and mode of oviposition.

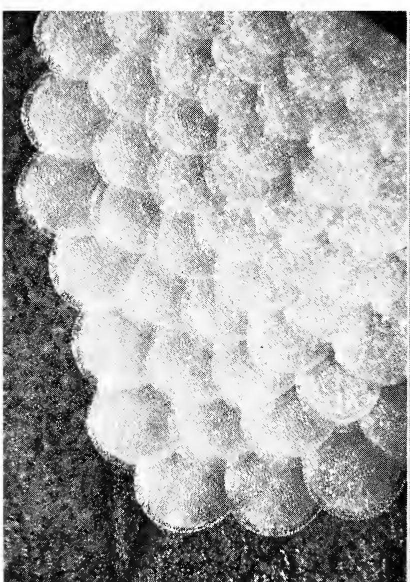
Size = 1.55-1.45 x 1.25-1.20 mm.

Fig. 8: *Pterolocera* sp., close to *amplicornis* Walker (det. NM) An.6

(Hallett Cove, S. of Adelaide, South Australia; APR.). The eggs of this species are apparently not deposited in masses like the preceding, although this needs further verification. The inset (upper right) shows the top (micropylar) end of an egg, at slightly higher magnification than the other three. The shells are opaque mottled with brown and white (no surface shine), and tough. The adult female moths of this genus are wingless. The adult males of this species (and the preceding) look rather similar at first glance, but clear-cut differences in the eggs of these two species are immediately obvious (in shape, maculation, and mode of oviposition). This species occurs in various (restricted) grassy localities near Adelaide, and on Kangaroo Island at Seal Bay (probably also elsewhere).
Size = 1.55 x 1.05-1.00 mm.

Fam. CARTHAEIDAE (Common, 1966)

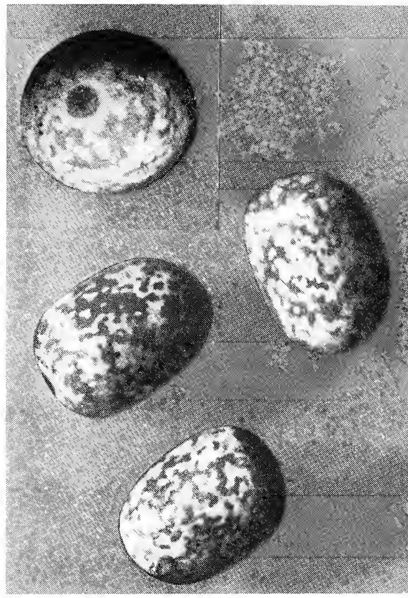
Fig. 9: *Carthaea saturnioides* Walker (det. NM) Ca.1
(Stirling Range, near Toolbrunup Peak, Western Australia, in a roadside gravel quarry; late SEP.-early DEC.). For details on the larval, pupal, and adult stages of this superb moth, see Common (1966). The egg is at first a uniform light honey-yellowish, and relatively smooth, with a bright surface shine; prior to hatching it becomes black (the color of the larva showing through the colorless, transparent shell). The shell is not



5

6

7



8

as tough or rigid as in most *Bombycoidea*. They are usually glued irregularly in small groups (twos or threes), on the new leaves of the foodplant(s).
Size = 1.85-1.70 x 1.55-1.50 x 1.50-1.45 mm.

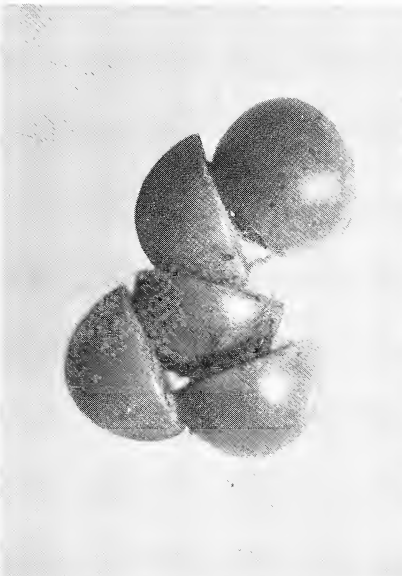
Spf. NOTODONTOIDEA
Fam. NOTODONTIDAE

Fig. 10: *Danima banksiae* (Lewin) (det. NM) Nd.15B (10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia, on the land of G. D. Seton; recorded for most months, but especially late AUG.-OCT.). These large, intensely chalk-white eggs are so conspicuous on the dark green linear leaves of the foodplant that they are quite easily seen with the naked eye from distances of 10 feet and more! They are usually deposited singly. The eggs in the photo were field-collected in mid OCT. 1966. Of about 60 eggs thus collected, 18 proved to be parasitized by a minute black wasp, of which an average of 7 to 10 wasps emerged from each egg, through a single, *small* round exit-hole cut through the side or top of the egg. The small dark spot, on the uppermost egg in the photo, shows the normal appearance of the micropylar area (*not* a wasp exit-hole). The inset shows a partially-eaten shell from which the larva has recently chewed its way to freedom. Note that the shell is uniformly *opaque*, which is *not* a common feature among eggs of the "Macrolepidoptera", except among the Bombycoidea and Notodontoidea. When eggs are completely opaque, it is of course, not possible to see any color changes as the larvae develop inside. In the case of *D. banksiae*, the egg remains chalk-white right up to the hour of hatching, even though the young larva emerging from it is black. (See also the seventh paragraph of the paper that follows).
Size (Kangaroo Island population) = 2.00-1.85 x 1.40-1.35 mm.

Fig. 11: *Hylaeora dilucida* Felder (det. IFC) Nd.14 (Blackwood, South Australia; MAR.-early MAY). These eggs illustrate the most common notodontid egg profile—quite flat on the bottom and evenly dome-shaped above, without ridges or other major surface sculpturing. (Similar egg shapes are seen in many Northern Hemisphere notodontids). The shell is very tough in this species, but *not* opaque. The egg goes through a series of striking color changes during incubation: At first, light pearl-gray (surface glossy), then becoming pale reddish-purple-gray, to rich opaque reddish-purple, to dark gray before hatching. Took 20 days to hatch (autumn).
Size = 2.20 x 1.40-1.30 mm.

9

10



11

12

Fam. THAUMETOPOEIDAE

Fig. 12: *Epicoma melanosticta* Donovan (det. IFC) Ta.5 (Blackwood, South Australia; NOV.-MAY). These eggs are glossy whitish, opaque, and evenly-curving over the top, with flat bottoms, but the lower rim is not sharp. During oviposition they are covered with (and interwoven among) *pale* golden-tan (soft) deciduous scales ("hairs") from the tip of the female's abdomen, which bind them together into a somewhat flexible cluster. There is little or no adhesive involved; the eggs are fairly loose within the soft binding-coat (in contrast with those in Fig. 13, which are securely glued to the substrate in addition to being hair-coated). In the photograph the egg mass is shown as lighted from beneath. Took 19 days to hatch (late summer).

Size = 0.90-*0.85*-0.80 x *0.75*-0.70 mm.

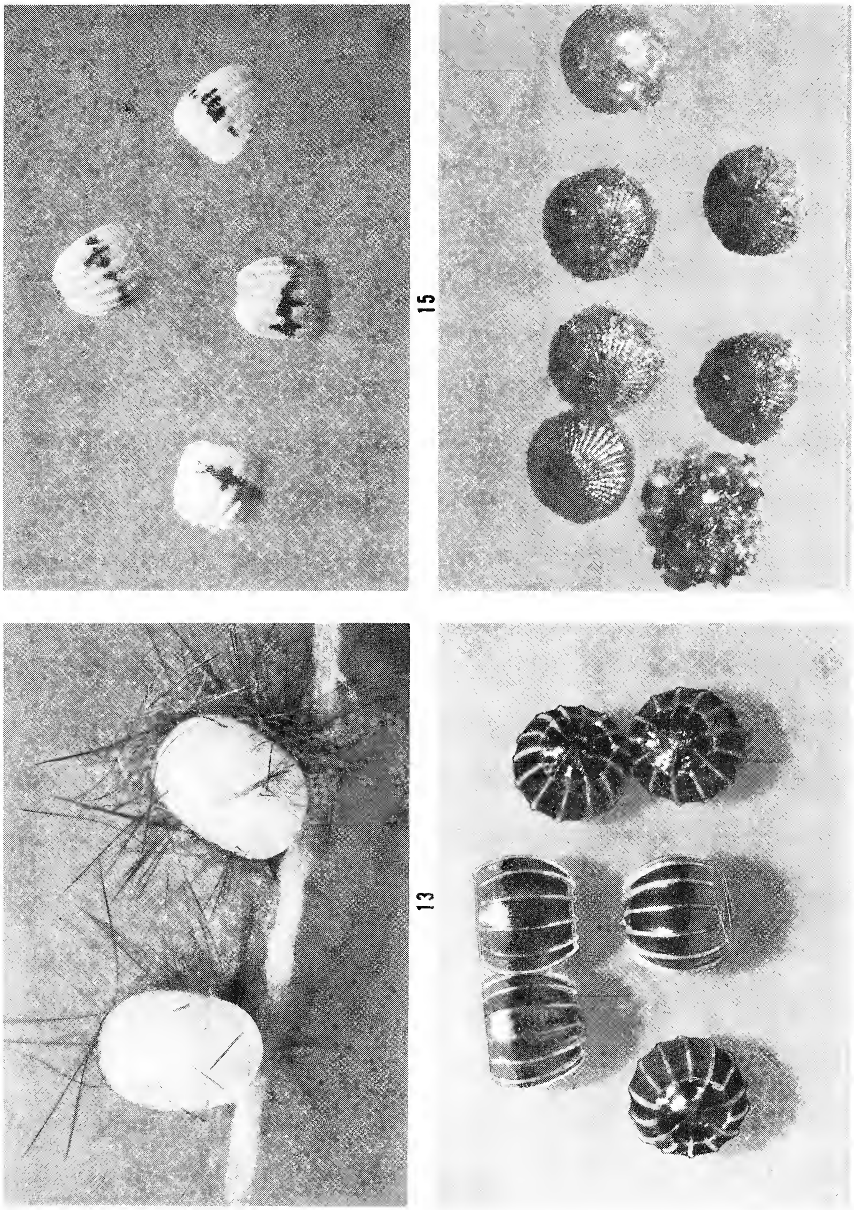
Fig. 13: *Oenosandra boisduvalii* Newman (det. DSF) Ta.1 (Blackwood, South Australia; mid MAR.-mid MAY). The two eggs shown have been removed from the egg mass typical of this species, which is densely-coated and bristling with dark deciduous scales from the tip of the female's abdomen. Some of the bristling coat still adheres to these eggs, although most has been rubbed off. They are shown standing end-up, as they were glued to one of the strands of muslin upon which the mass (originally of 25 eggs) was deposited. The elongate-cylindrical egg shape, with weak longitudinal grooves, is unusual in the Notodontoidea. Took 35 days to hatch (autumn).

Size = 1.25-1.20 x 1.00-0.85 mm.

Fig. 14: *Discophlebia catocalina* Felder & Rogenhf. (det. DSF) Ta.3

(Blackwood, South Australia; mid NOV.-early FEB.). These eggs are securely glued upright, in short irregular rows and smaller groups (sides usually stuck together), never with any attached scales or "hairs". They are prominently ribbed and very shiny (unusual in the Notodontoidea, with a peculiar, irregular two-tone (internal) color pattern. The lower one-third or one-quarter of the egg is milky-whitish, while the remaining upper area is dark sooty-brown. The two uppermost eggs, and one in the middle, are seen lying on their sides; the other three are standing upright in the way they are deposited. Took 12 days to hatch (summer).

Size = 1.00 x 1.00-0.90 mm.



13 14 15 16

Spf. NOCTUOIDEA

Fam. NOCTUIDAE

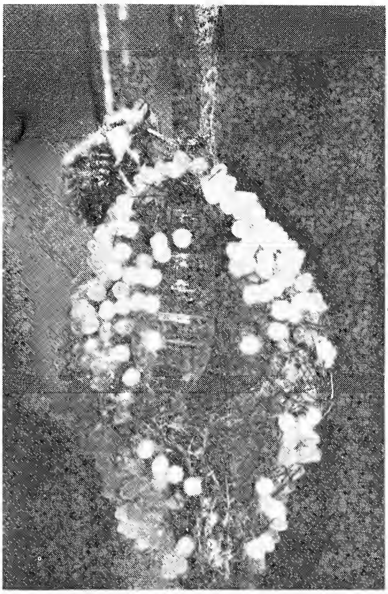
Fig. 15: *Cosmodes elegans* Donovan (det. NM) N.110 (Blackwood, South Australia; OCT.-JUNE). In some respects, the general appearance of this egg is typical of many noctuid eggs. Note the prominent ribs. When first deposited these eggs are pure white. After a day or two, an irregular dark brown band-pattern can be seen developing through the shell as changes take place inside. The eggs of this species are deposited very weakly-glued or unattached.
Size = 0.60-*0.55* x 0.55-*0.50* mm. (Blackwood); 0.50-*0.45* x 0.50-0.45 mm. (Aldgate, S.A.—a considerably cooler and wetter locality in the Mt. Lofty Range, with approx. 40 inches annual rainfall).

Fam. AGARISTIDAE

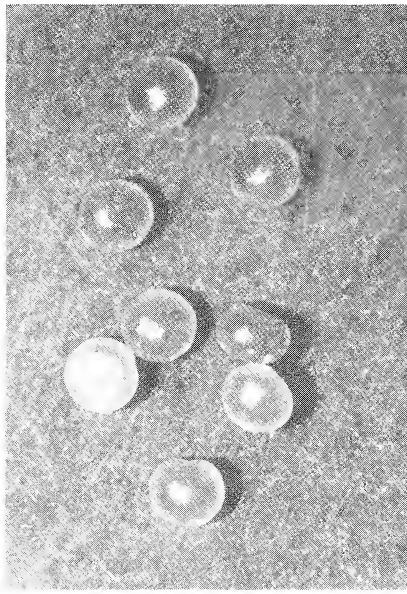
Fig. 16: *Apina callisto* Walker (det. NM) As.8 (Walkerville, suburb of Adelaide city area, South Australia; mid APR.-mid MAY; adults diurnal). This species seems to occur in very localized colonies, in open grassy-weedy areas (parklands or roadsides, etc.), but can be abundant where present. The behavior of the female during oviposition is most distinctive. Eggs are deposited on the ground, attached to bits of litter or soil particles, etc. (At the time of adult emergence, the annual foodplants are not usually present on the dry ground). Just prior to oviposition, the female crawls along, "dabbling" the tip of her abdomen in dusty-dry soil, picking up fine particles. A few eggs are then deposited, and the first of these will be heavily coated with soil (see one in lower left corner). The soil-dabbling is then repeated during a short walk by the moth, and a few more eggs are deposited. Most of those in the photo have been brushed partially clean, to show the distinctive radiate sculpturing on the upper surface of the shell, but the one at the lower left, with fine sand grains adhering to it, represents the natural condition of a first egg deposited after soil-dabbling. (This may serve as a defense against ants or other soil predators?) The one at the far right shows the smooth and shiny underside, rubbed clean of soil particles.
Size = 0.80-0.75 x 0.60-0.50 mm.

Fam. NOLIDAE

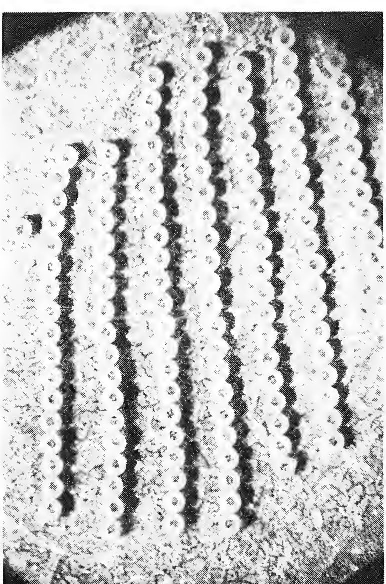
Fig. 17: *Uraba lugens* (Walker) (det. DSF) N1.2 (Blackwood, South Australia; OCT.-DEC. and late FEB.-APR.). These eggs were included primarily to illustrate the distinctive oviposition-pattern (neatly-spaced parallel rows); also, to show



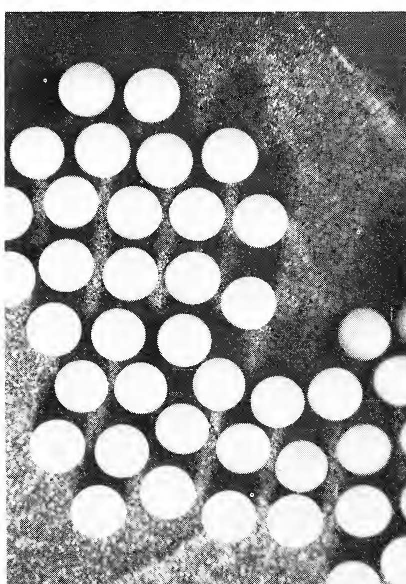
19



20



17



18

the notably transparent central area, typical of many nolid eggs. They are shown as they were deposited, securely glued to the foodplant leaf with a colorless adhesive, and no covering of "hairs". There are sometimes as many as 10± rows (of similar length) deposited on one leaf. The young larvae are highly gregarious, feeding closely side by side on a single leaf. As they become larger they gradually disperse. This species often (seasonally) approaches pest status in southeastern Australia, defoliating *Eucalyptus* spp. (Myrtacae).

Fam. ARCTIIDAE, Sbf. NYCTEMERINAE

Fig. 18: *Nyctemera amica* (White) (det. NM) Ar.39

(Blackwood, South Australia; recorded for all months, with peaks in JAN-MAR. and MAY-JUNE). These rounded, smooth, shiny eggs are, in general appearance, typical of many arctiid eggs the world over. The color is at first cream-white, with a gleaming, pearly surface-luster. They are flattened on the bottom (where attached), and so are not perfectly round, although they seem to be when viewed from above. It is interesting to note that this species does not deposit its eggs in actual contact with each other, even though they are *very* close together in a mass formation. The precise spacing is always maintained (typical of numerous arctiids). Part of a mass is here shown attached to the surface of the foodplant leaf. Took 6 days to hatch (summer).

Size = 0.70 x 0.60 mm.

Fam. ARCTIIDAE, Sbf. LITHOSIINAE

Fig. 19: *Xanthodule ombrophanes* (Meyrick)
(det. IFC) Ar.38

(Blackwood, South Australia; OCT.-NOV. and FEB.-JUNE, reaching a peak in APR.-MAY; only ♂ comes to light, mostly *after* midnight). This photograph is a rather poor copy from a color slide, but was included because it depicts a most unusual form of oviposition among the *Arctiidae*. The flightless (brachypterous) female moth waits on the outside of her cocoon until a flying male locates her (much as in the style of certain lymantriids of the genus *Orgyia*). After mating, the female rapidly deposits the eggs (with no coating of any sort) all over the surface of the cocoon, and then dies. In the photograph, the shrivelled adult female (about to die), having laid all her eggs, is seen clinging to the outside of her cocoon; the thin, shiny and nearly colorless empty pupal shell, from which she had emerged a day or two earlier (with a huge abdomen swollen with eggs),

can be vaguely seen inside the cocoon. The egg shape might best be described as bluntly pyramidal.

Fig. 20: *Scoliacma bicolora* (Boisduval) (det. IFC) Ar.37 (Blackwood, South Australia; OCT.-NOV. and JAN.-mid APR.; the main flight is the spring brood). The eggs in the photo are from Aldgate, S. Aust., in the Mt. Lofty Range not far from Blackwood; Andrew Smith, collector. A unique feature of these small eggs, which are glued in groups close together but *not* touching (much like those in Fig. 18), is their almost water-clear translucence when freshly oviposited. The uppermost egg is turned over, showing the more flattened underside, which has been slightly dented. The second egg from the left, in the lower row, is standing on its edge, showing the lateral profile (its bottom faces to the right). The newly-hatched larvae eat their transparent egg shells almost entirely before dispersing.
Size = 0.55-0.50 x 0.40-0.35 mm.

Figs. 21-48: Entirely of the Family Geometridae

Spf. GEOMETROIDEA
Fam. GEOMETRIDAE
Sbf. GEOMETRINAE (Hemitheinae)

Fig. 21: *Hypobapta eugramma* (Lower) (det. IFC) Gm.125 (Blackwood, South Australia; NOV.-early APR.). The intense white parallel lines are in the shell of the egg (opaque), and thus do not change when the internal colors do; the rest of the shell is translucent. The space between these lines becomes vivid reddish-pink after several days, and then changes to dark gray prior to hatching of the larvae. Major color changes are visible in the eggs of most species of geometrids during incubation, as nearly all have (more-or-less) transparent shells. These eggs have been removed from the substrate, but some still remain attached to each other *at odd angles,* which is typical of the oviposition style in this species, at least when in confinement. (A close relative, *H. percomptaria* (Gn.), my Gm.88, deposits a similar but slightly less elongate egg, which entirely lacks the white lines and has, instead, a small but intense white spot at the smaller end). Took 10 days to hatch (summer). See also Figs. 41-42 (S.E.M. photos of this species).
Size = 1.45-1.30 x 0.90-0.80 x 0.75-0.70 mm.

Fig. 22: *Cyneoterpna wilsoni* Felder (det. DSF) Gm.162 (Blackwood, South Australia; AUG.-APR.; reaching a peak from DEC.-FEB.). The photo depicts the eggs as they are often attached, singly or in irregular short stacks (securely glued), at

the tips of small new leaves of the foodplant. They are a pure, pale green when first deposited (surface shiny). Took 8 days to hatch (summer).

Size = 1.10-1.00 x 0.70-0.60 x 0.60-0.50 mm.

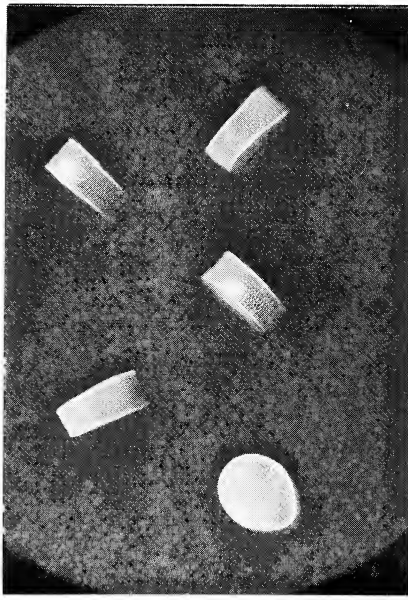
Fig. 23: *Eucyclodes buprestaria* Guenée (det. NM) Gm.175A (Aldgate, Mt. Lofty Range, South Australia; OCT.-FEB.). Through the kindness of Andrew Smith, I was give a series of eggs obtained from a confined female in DEC. 1969. Two outstanding features of these eggs, when compared with the eggs of other South Australian Geometrinae, are the sharply-defined *rims* in combination with the notably *flat* upper and lower surfaces. The photo shows 4 eggs standing on edge and one lying flat (lower left). Color, for most of the incubation period, is a deep yellow. Mostly deposited singly, glued to the foodplant stems or tips. Took 16 days to hatch (summer).
Size = 0.90-*0.85*-0.80 x *0.70*-0.65 x 0.45-*0.40*-0.35 mm.

Fam. GEOMETRIDAE, Sbf. OENOCHROMINAE

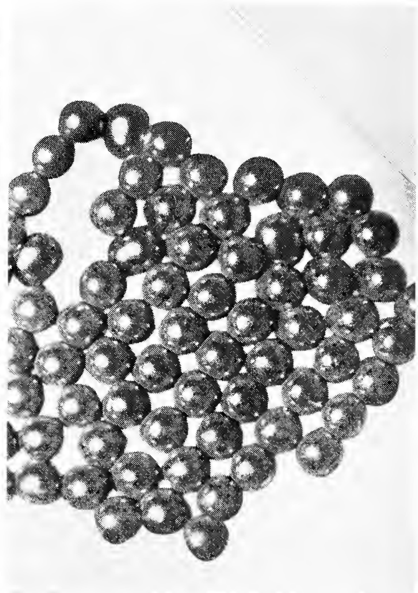
Fig. 24: *Arhodia lasiocamparia* Guenée (det. DSF) G.124 (Blackwood, South Australia; SEP.-mid MAR.). A large single layer mass was deposited by a confined female of this species, with the eggs securely glued to the sides of each other, mostly end up, although three can be seen tipped sideways, near the upper right of the photo. Another species in the same genus (slightly smaller, with more maculation on the forewing, my G.163) deposits its egg mass in the form of an encircling-band around a twig, with no covering substance, somewhat reminiscent of the egg mass type deposited by certain American *Hemileuca* spp. (Saturniidae). It is possible that *A. lasiocamparia* may also deposit an encircling-band, if ovipositing on a twig. My observations are limited to females confined in jars with muslin strips, where they could not have possibly deposited encircling-bands, even if that had been the normal habit. Through all color changes, from dark gray with a faint green tinge to gray-brown to coppery reddish-*brown* to deep lead gray, there is a gleaming pearly-gold surface sheen on the shell. Took 15 days to hatch.

Size = 0.95-*0.90-0.85* x 0.75-0.70 x 0.70-0.65 mm.

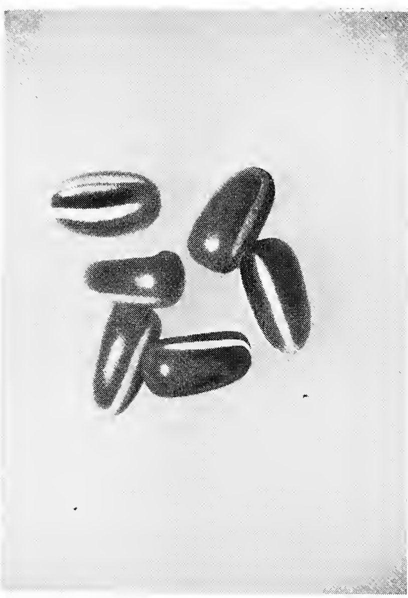
Fig. 25: *Hypographa aristarcha* Prout (det. IFC) G.184 (10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia, on the land of G. D. Seton; late AUG.-OCT.). These eggs are deposited singly or irregularly in small clusters (2 or



23



24



21

22

3), strongly-glued to the foodplant leaves. The superb coloring consists of an irregular speckling in deep blood-red, on a gleaming (shiny) pearl-white background. Prior to hatching, the speckles disappear and the color becomes uniformly blackish (color of the fully-developed larva inside). Took 19 days to hatch (early spring).

Size = 1.10-1.05 x 0.80-0.75 x 0.70 mm.

Fig. 26: *Dinophalus drakei* (Prout) (det. IFC) G.194 (Near the base of Black Hill, Athelstone, E. of Adelaide, South Australia; late SEP.-OCT.). This species is under the genus *Ophiographa* in the British Mus. (N.H.). Similarities can be seen between the eggs of this species and those of *Hypographa aristarcha*. In the smaller *D. drakei* egg, the speckling is fainter (less intense), more regular in its spacing, and the surface shine is less.

Size = 0.90 x 0.70 x 0.60 mm.

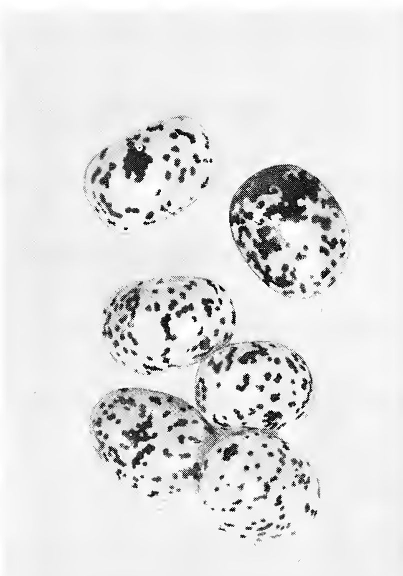
Fig. 27: *Monoctenia smerintharia* Felder (det. DSF) G.94 (Blackwood, South Australia; late FEB.-APR.). These eggs were included for comparison with those of the next species. Good differences are evident, yet it is easy to see many similarities in the eggs of these two closely-related moths. In this species, the speckling varies from dark red-purple to dark red-brown (on a pale gray background), depending on the age of the eggs. Took 35 days to hatch (autumn).

Size = 1.75-1.65 x 1.40-1.30 x 1.10-1.00 mm.

Fig. 28: *Monoctenia falernaria* Guenée (det. DSF) G.167 (Blackwood, South Australia; mid MAR.-mid APR.). The middle egg is only a few hours old, and has not yet developed the (internal) speckling, which can be seen through the transparent shells of the other two. Very dark reddish speckles develop, on the pale cream-tan background, after several days. *Not only do these eggs vary exceedingly in size, but also in proportions* (length to width); the series measured were all from one female! These great size differences are instantly apparent, even to the naked eye. Took 14 days to hatch (autumn), a much shorter incubation period than in *M. smerintharia*.

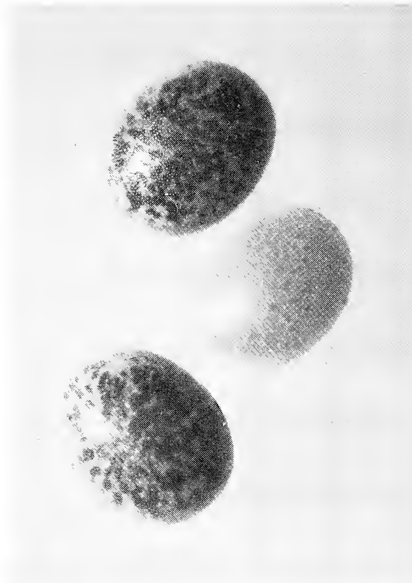
Size = 1.95-1.40 x 1.40-1.15 x 1.10-1.00 mm.

Fig. 29: *Phallaria ophiusaria* Guenée (det. DSF) G.80 (Blackwood, South Australia; late FEB.-mid MAR.). This is one of the few large geometrids that deposits a very weakly-


25


26


27


28

attached egg, which falls to the ground at the slightest touch. (Essentially, it could be thought of as an unattached egg). The eggs in the photo show a little collapse at the sides, but this only happens later in incubation; when first deposited, they are *almost* perfect spheres and pure white. Red speckles soon develop and darken in a few days. Took between 14 to 22 days to hatch, varying to this extent within a single batch from one female, all of which had been oviposited in a period of two nights. (Possibly this species is on the borderline of a "rain-hatched" tendency? See paper that follows).

Size = 1.25-1.20 x 1.20-1.15 mm.

Fig. 30: *Rhynchopsota rhyncophora* (Lower)
(det. DSF) G.127
(Blackwood and Eden Hills, South Australia; late MAY-JUNE). This moth is perhaps best assigned to the Oenochrominae; more larval and pupal material should eventually clarify the matter. With reference to the generic placement of this species (type specimen under "*Chlenias*", in S.A. Museum, Adelaide; under "*Amelora*" in the Brit. Mus.), I quote the following from D. S. Fletcher (Apr. 71): "*Rhynchopsota* is at present included in the generic synonymy of *Amelora* Guest, but is structurally distinct." (This statement is based on a genitalic slide made by Fletcher, of my G.127, in April, 1971). The genus contains one other described species, *R. delogramma* Lower.

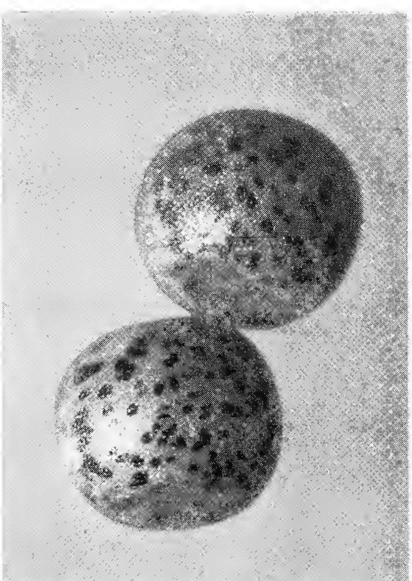
A single egg is here shown as attached by the female moth during oviposition, in an axil of a younger stem of the foodplant. Eggs are usually deposited singly (occasionally in twos or threes), in crevices between small flakes on the foodplant stems, or in stem axils, securely glued. Color and maculation of individual eggs varies considerably during incubation. Took 40 days to hatch (winter).

Size = 0.95-0.85 x 0.75-0.65 x 0.55-0.50 mm.

Fam. GEOMETRIDAE

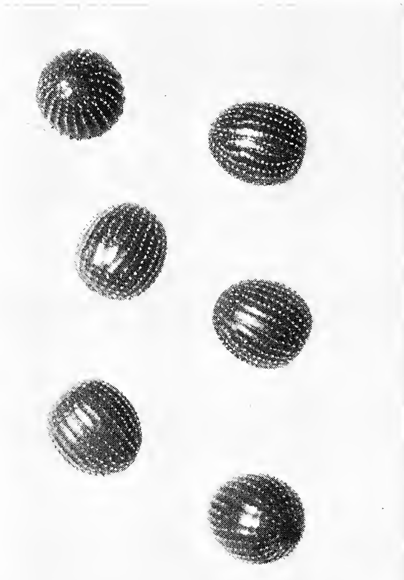
Sbf. ENNOMINAE (Boarmiinae)

Fig. 31: *Idiodes apicata* Guenée (det. DSF) G.147
(Blackwood, South Australia; recorded for every month, with peaks in DEC.-JAN. and JULY-AUG.). This species drops its eggs free—entirely unattached. Note the roughly parallel rows of small white "pustules". These white "dots", appearing as white "pustules" at lower magnifications, are actually raised and closely adjoining white rings (mostly paired), and looking



29

30



31

32

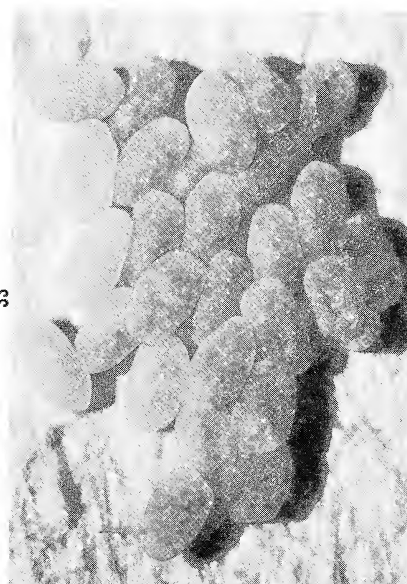
like the figure-8. These morphological details can be seen clearly in the S.E.M. photos of the egg of this same species (Figs. 45-48). The ground color of this egg is at first cream, then changing to milky-orange, to light pinkish-*orange*, to deep pinkish-*orange* (salmon), to gray-brown prior to hatching; through all color changes the "pustules" remain white. A batch of these eggs obtained in JAN. 1969 (mid summer) took 5 to 6 days to hatch; a batch obtained 24 NOV. 65 (early summer) took 8 days; a batch obtained 25 JULY 66 (mid winter) took 19 days to hatch. (In each of these instances the eggs were indoors, in a room not artificially heated or cooled, subject to all natural fluctuations in temperature of the habitat outdoors.)
Size = *0.65*-0.60 x *0.60*-*0.55*-0.50 mm.

Fig. 32: *Stibaroma melanotoxa* Guest (det. IFC) G.81 (Blackwood, South Australia; late FEB.-MAY). These eggs are usually deposited in *long*, irregular rows or groups; also some scattered in smaller groups and a few singles (when in confinement). The shape is almost uniformly elongate-cylindrical. At the larger end there is a peculiar area, giving a color-and-texture impression of fine, whitish foam-plastic (sub-surface). (There is a similar appearance to the larger end of the egg of *Thalaina angulosa*, Fig. 38). The eggs of S. *melanotoxa* are at fiirst pale gray with a faint pinkish tinge and a gleaming surface sheen; later in incubation they darken to a deep gray-brown (surface sheen remaining). Took 22 days to hatch (autumn).
Size = *0.90*-*0.85*-0.80 x 0.60-0.55 mm.

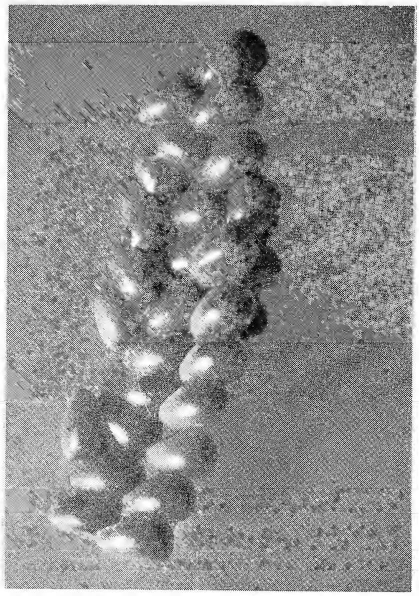
Fig. 33: *Cleora bitaeniaria* (LeGuillou) (det. IFC) G.86 (Blackwood, South Australia; recorded for every month, but somewhat more abundant in SEP., and from DEC.-JUNE). These distinctive eggs are lightly glued on their sides, mostly singly or in small groups or "masses". They go through a sequence of major color changes, as follows: At first dark greenish red-brown, then to uniformly rich red-brown, to translucent dull raspberry-red, to darker before hatching. Took 16 days to hatch (early autumn). See also Figs. 43-44 (S.E.M. photos of this species).
Size = 1.25-*1.20*-1.05 x 0.70-0.60 x 0.60-0.55 mm.

Fig. 34: *Cleora displicata* Walker (det. DSF) G.165 (Blackwood, South Australia; OCT.-APR., reaching a peak in JAN.-MAR.). The female moth has a *long* ovipositor, with which she inserts her notably soft-shelled eggs into crevices or under loose bark, on the stems of the foodplant. The egg mass

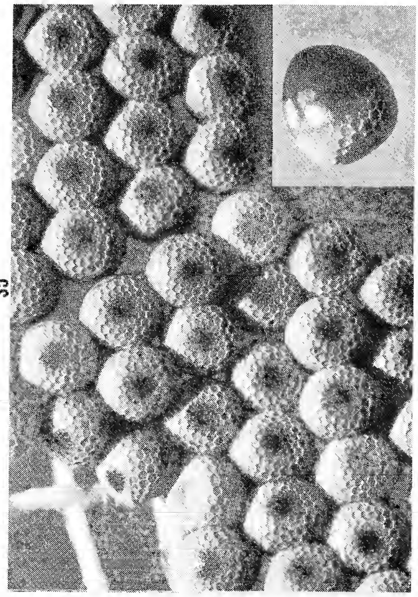
33



34



35



36

is irregular and may be more than one layer deep, more-or-less filling (or conforming to) part of the space inside a crevice. Unprotected in the open, these eggs desiccate rather easily. As is well depicted by the photo, the eggs are very pale in color and translucent. They are at first a clear lime-green, later becoming pale yellowish-green, then to yellow-gray, to gray prior to hatching. Took ±10 days to hatch (summer).

Size = 0.80-0.70 x 0.55-0.50 x 0.45-0.40 mm.

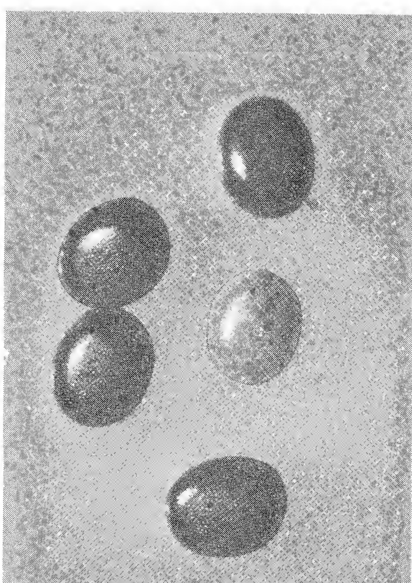
Fig. 35: *Mnesampela fucata* (Felder) (det. DSF) G.109 (Blackwood, South Australia; mid MAR.-JUNE). These eggs are deposited in irregular but distinctive masses and strings, often being stacked upward from the surface where they are attached. The adhesive is exceptionally strong and thoroughly waterproof. This is one of the prime examples of a "rain-hatched egg", as well as having "first instar dispersal behavior" strongly developed; these phenomena are discussed at length in the paper that follows.

Size = 1.30-1.20 x 0.90-0.85 x 0.80-0.75 mm.

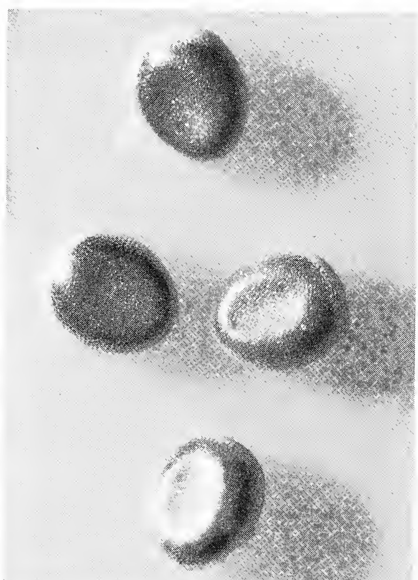
Fig. 36: *Capusa cuculloides* Felder (det. DSF) G.105 (Blackwood, South Australia; late MAY-JULY). Mr. Fletcher (Apr. 71) kindly prepared and compared genitalic slides of *Capusa cuculloides* Felder and *C. stenophara* Turner, and found them to be identical. (This sp. appears under *stenophara* Turner in some Australian collections). The photo shows only a small section of one of the huge, elongate egg masses (deposited by a single female), as seen from above. A single mass sometimes contains more than 300 eggs. The eggs are very securely glued together with a waterproof adhesive. The inset shows one egg (at much greater magnification), detached from the mass and turned on its side. Note that the distinctive net-like surface-sculpturing only extends to less than halfway down from the top, thence fading out; the rest of the egg is smooth and tapered, with the lower section changing in color from pale gray-green to gray-brown during incubation. The resemblance to an acorn cannot be missed! Took 20 days to hatch (winter).

Size = 0.75-0.70 x 0.70-0.65 mm.

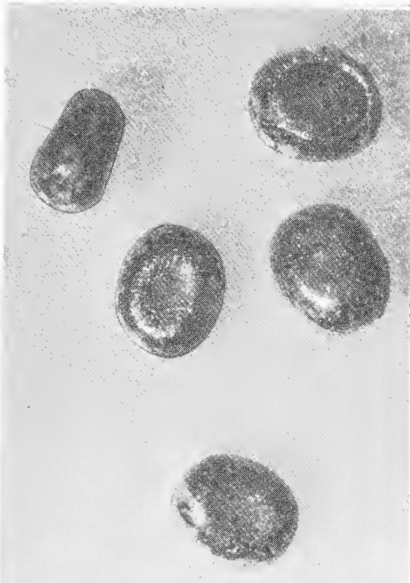
Fig. 37: *Lophothalaina habrocosma* (Lower) (det. NM) G.154 (Blackwood, South Australia; APR.). The type specimen is under "*Pseudopanthera*" in the S.A. Mus. (Adelaide). The eggs of this scarce and distinctive geometrid are glued singly, or in twos (flat side down), to the foodplant leaves. A pitted surface



37



38



39

40

texture occupies a clearly-defined zone, in the more central area of the flat upper and lower surfaces of the egg; this is bordered by a relatively smoother area of the shell surface. (The egg at the far left shows this fairly well; note reflected light on the smoother bordering zone). For most of the incubation period, these eggs are a deep yellow-cream centrally, tinged with orange around the edges. Somewhat of a "rain-hatched" tendency was noted in these eggs, but this is apparently not an absolute necessity for successful hatching. Took 13 days to hatch.

Size = 0.90-0.85 x 0.70 x 0.50 mm.

Fig. 38: *Thalaina angulosa* Walker (det. DSF) G.100 (Blackwood, South Australia; mid MAR.-MAY). These eggs are mostly glued singly, or in twos and threes, on leaves and stems of the foodplant. See remarks under *Stibaroma melanotoxa* (Fig. 32) with reference to the appearance of the larger end of this egg. This is another excellent example of a "rain-hatched" egg. The first batch obtained (APR. 65) were kept for 6 weeks before the idea of dipping them in water occurred to me; this caused rapid hatching of all the eggs, which had appeared ready to hatch for *many* days, but not one had hatched prior to this wetting. In the case of some (from the same batch) left entirely dry, there was no sign of hatching long after all of the water-dipped eggs had hatched. (See the paper that follows for a discussion of "rain-hatched eggs"). During incubation, the eggs change in color from opaque pale green to gray-green to gray to light gray-brown.

Size = *1.10*-1.00 x 0.80 x 0.60 mm.

Fig. 39: *Melanodes anthracitaria* Guenée (det. DSF) G.161 (Blackwood, South Australia; mid SEP.-DEC.). As these lozenge-shaped eggs mature, a slight concavity develops on the flat surface. The one at the upper right has been balanced on its edge to show the lateral profile. The eggs are deposited flat side down, in irregular but distinctive one-layer "masses" (often large), where *no egg touches another,* even though all are very close together. All eggs are aligned in the same direction within the mass. They are securely-glued with a colorless adhesive. It is probable that the moth oviposits on the (smooth) surfaces of the foodplant leaves under natural conditions. (In a glass jar, it showed a distinct preference for ovipositing on the sides of the jar, even though a muslin strip was provided). Took 11 days to hatch, with most of the larvae emerging between 9:00-10:00 A.M. (spring).

Size = 0.90-0.80 x 0.70-0.60 x 0.50-0.45 mm.

Fig. 40: *Niceteria macrocosma* (Lower) (det. NM) G.200 (Blackwood, South Australia; FEB.-early APR.). The eggs of this relatively uncommon and showy geometrid are securely-glued (singly, or in twos) at the tip, or along the margin, of the foodplant leaf. When seen from the side, the egg profile is a "tapered oval", which becomes thinner toward the small end (shaped much like those of *Mnesampela fucata,* Fig. 35). An irregular, reddish-pink band-like pattern develops around the edges except at the small end. Took 11-12 days to hatch (no wetting required).
Size = 1.35-1.30 x 1.05-0.95 x 0.80-0.75 mm.

Figs. 41-48: These microphotographs, obtained by scanning electron microscopy (SEM) techniques, have been included for comparison with Figs. 21, 33, and 31, respectively, which species they represent. These eight photographs were provided through the kindness of Mr. A. C. Allyn and Dr. L. D. Miller, of the Allyn Museum of Entomology, Sarasota, Florida, U.S.A. All of them are made from *empty* (hatched) egg shells of the species involved.

Figs. 41, 42 (for full data, see also Fig. 21) — *Hypobapta eugramma* (Lower).

Fig. 41: Magnification 65x (Allyn Mus. photo no. 072971-10, mount no. 70; SEM-S1; Dec. 1971).

Fig. 42: 300x (A. M. photo no. 0058, mount no. 70; SEM-U3; Dec. 1971).

Remarks: Fig. 41 represents a relatively rigid egg shell, which maintains its shape well—no collapse. (The slight concavity visible on the flattened upper surface is typical of the *H. eugramma* egg shape). The "intense white parallel lines", described under Fig. 21, are not visible here, as the egg shell has been gold-*coated* prior to making the SEM photos. Note the subtle but definite surface-detail. This egg appears essentially "smooth" at low magnification, or to the naked eye. Fig. 42 shows the surface structure in still greater detail, and also a belt of pores. Particles of debris, in both of these photos, should be ignored.

Figs. 43, 44 (see also Fig. 33) — *Cleora bitaeniaria* (LeGuill.)

Fig. 43: 100x (A. M. photo no. 072971-3, mount no. 67; SEM-S1; Dec. 1971).

Fig. 44: 300x (A. M. photo no. 0059, mount no. 89; SEM-U3; Dec. 1971).

Remarks: Fig. 43 shows considerable collapse, due to the frailty of the empty egg shell of this species. Surface structure is seen to be far more intricate than Fig. 33 would lead one to believe; still greater detail is shown in Fig. 44.

Figs. 45-48 (see also Fig. 31) — *Idiodes apicata* Gn.

Fig. 45: 130x (A. M. photo no. 072971-1, mount no. 66; SEM-S-1; Dec. 1971).

Fig. 46: 140x (A. M. photo no. 0039, mount no. 66; SEM-U3; Dec. 1971).

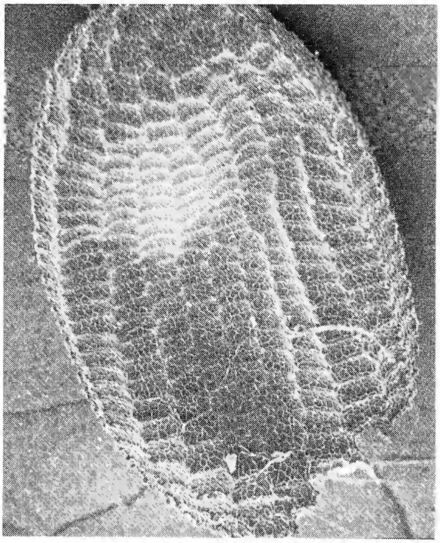
Fig. 47: 1000x (A. M. photo no. 0040, mount no. 66; SEM-U3; Dec. 1971).

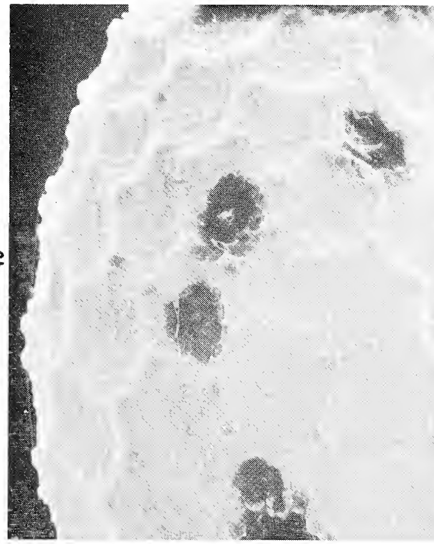
Fig. 48: 4000x (A. M. photo no. 0041, mount no. 66; SEM-U3; Dec. 1971).

Remarks: Figs. 45-46 show two different views of the empty egg shell, the latter including the micropyle. Due to the frailty of the empty shell of this species, some collapse is evident on the side (Fig. 46). The small white "dots" in parallel rows, appearing merely as small white pustules in Fig. 31, are here seen with far greater accuracy; note that the "pustules" are (mostly) *paired, ring-like,* and *partially fused* where they contact. Fig. 48 shows one of these paired rings at far greater magnification (data above). Fig. 47 shows detail of the micropylar region.

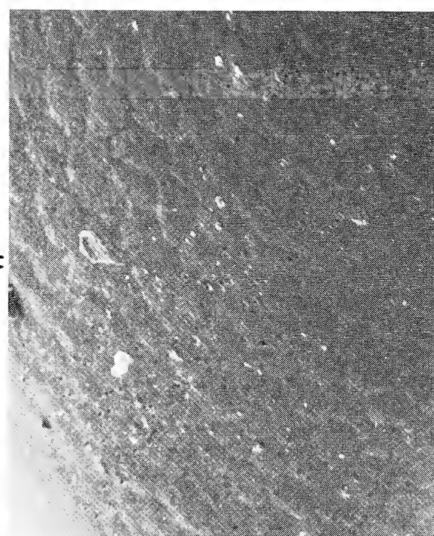
ACKNOWLEDGMENTS

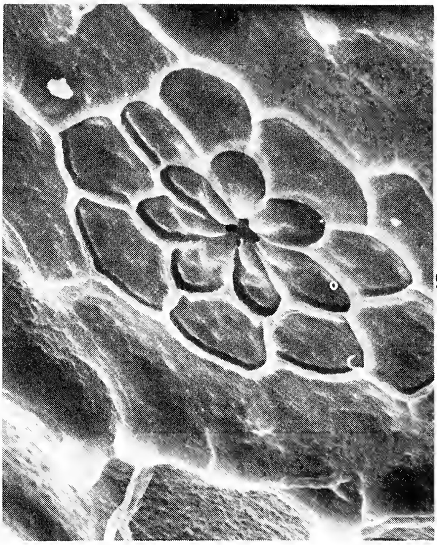
I am indebted to the Trustees of The Australian Museum, Sydney, for permission to use 19 of the first 20 photographs, and parts of the text, which had appeared earlier (as a shorter version) in the magazine, *Australian Natural History* (McFarland, 1970); to R. O. Ruehle (South Australian Museum) for all developing and printing of the photographs used in Figs. 1-40; to I. F. B. Common (C.S.I.R.O., Canberra), D. S. Fletcher and K. Brookes (British Museum of Natural History) for their help with the determinations of many of these species; to A. C. Allyn and L. D. Miller (Allyn Museum of Entomology, Sarasota, Florida) for producing the S.E.M. photos used in Figs. 41-48; to B. K. Head (South Australian Museum) for help with preparation of the black and white prints; to my wife, Dienie, for typing the manuscript; to the Directors and staff of the South Australian Museum (Adelaide), for their encouragement and assistance toward the continuation of this work, during my time there (1965-1970) as Assistant Curator of Insects.


43


44

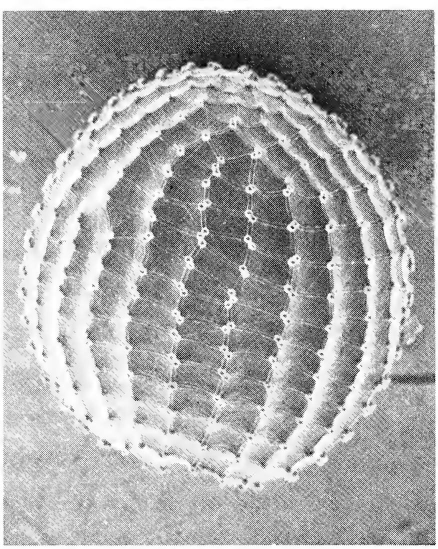

41


42

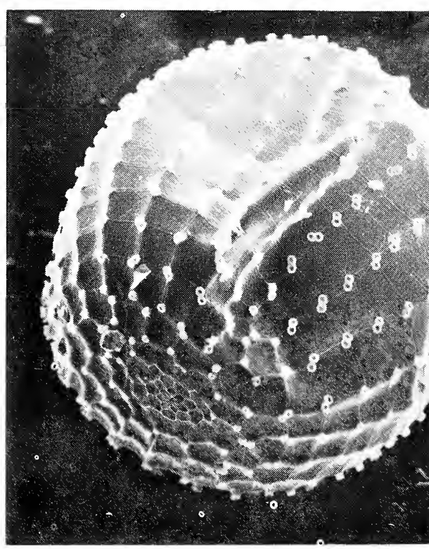


47

48



45



46

REFERENCES

COMMON, I. F. B. (1966): A New Family of Bombycoidea (Lepid.). Based on *Carthaea saturnioides* Walker from Western Australia. *J. Ent. Soc. Queensland* 5: 29-36.

——— (1970): *in* The Insects of Australia, A Textbook for Students and Research Workers, sponsored by Div. of Entomology, C.S.I.R.O.; *chapt. 36* (pp. 765-866) on the Lepidoptera. Melbourne University Press. 1029pp.

KARP, T. (1966): "Super Close-ups with your SLR." *Modern Photography* (Feb., 1966).

McFARLAND, N. (1964): Notes on Collecting, Rearing, and Preserving Larvae of Macrolepidoptera. *J. Lepid. Soc.* 18(4): 201-210.

——— (1965): Additional Notes on Rearing and Preserving Larvae of Macrolepidoptera. *J. Lepid. Soc.* 19(4): 233-236.

——— (1970): "Moth Eggs!" *Australian Natural History*: 346-352 (June, 1970).

Journal of Research on the Lepidoptera 10(3):248-254, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

IDENTITY OF THE MOTH *ONCOCNEMIS SEMICOLLARIS* J. B. SMITH

WITH NOTES AND DISTRIBUTION (LEPIDOPTERA: NOCTUIDAE)

J. S. BUCKETT
University of California,
Davis, California

Since the original description of *Oncocnemis semicollaris* J. B. Smith in 1909, the name has been a mystery. Some years ago specimens of an unknown *Oncocnemis* sp., near *figurata* Harvey, began accumulating in the Bauer-Buckett collection (now in the collection of the Entomology Department, University of California, Davis). In recent years additional specimens were received from Mr. Ken Goeden of the Oregon State Department of Agriculture, Salem, Oregon.

Through the courtesy of Mr. Lloyd M. Martin, then of the Los Angeles County Museum of Natural History, a picture of the type specimen of *O. semicollaris* was examined and compared to the unknown specimens; in addition I had notes concerning the type specimen I had drawn up while in New York in 1964. The type, contained in the American Museum of Natural History, New York, is in satisfactory condition and this photograph, in addition to the notes, were adequate to determine the identity of this heretofore unidentified *Oncocnemis.* The type specimen contains four labels: "Peachland, B.C. 8-VII-07, J. B. Wallis," "J. B. Smith Collection, Rutgers," "*Oncocnemis semi-collaris,* Type Sm." and "43." The hand written type label was one of Smith's typical red bordered labels.

As with many species of *Oncocnemis, O. semicollaris* is fairly widespread in western North America, ranging from British Columbia south to eastern central California (see distribution map, fig. 1).

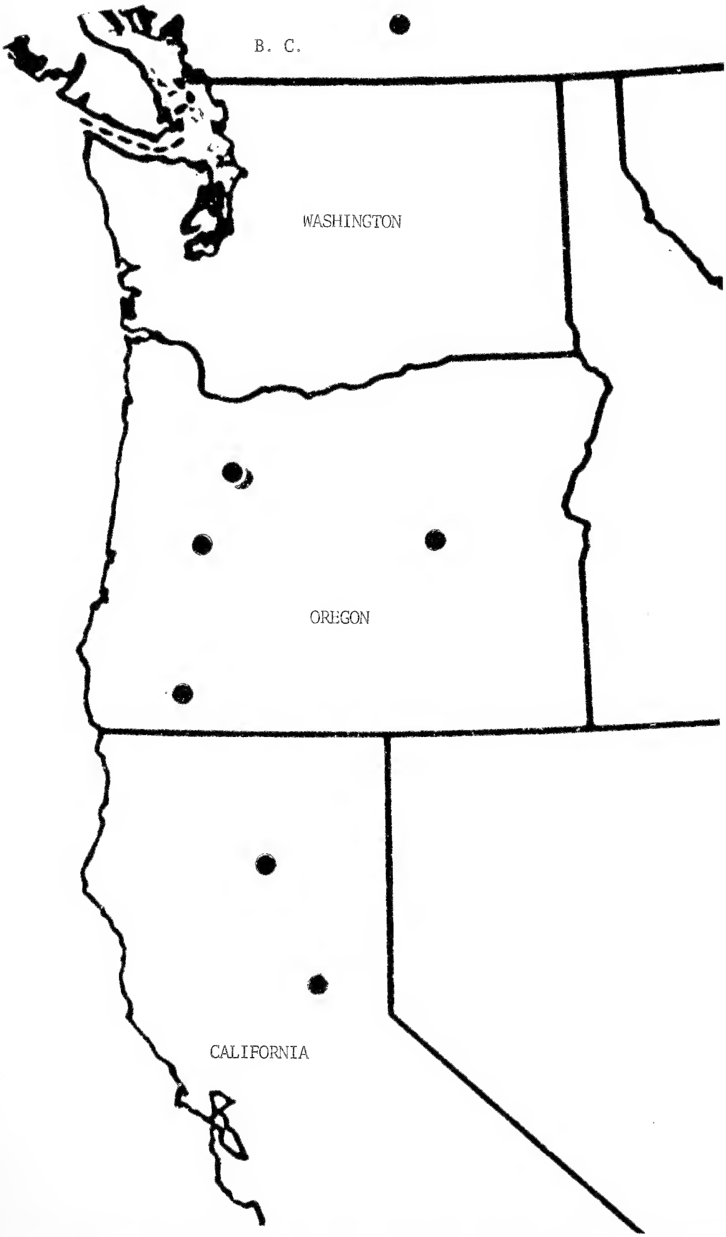


Fig. 1.—Distribution map depicting the known distribution of *O. semi-*

O. semicollaris is in the *figurata* group of the genus and is most closely related to *figurata* itself. This species has been confused with *figurata* in collections, but *semicollaris* can be readily distinguished by the yellowish-brown subterminal-terminal areas of the primaries, the strongly contrasting bicolor collar (which is basally black, remainder white), and the male genitalia (see figs. 4 and 5). On the vesica of the aedeagus, the band of spinules is in two distinct groups in *semicollaris*, whereas in *figurata* it is continuous. In addition, the costal and inner margins of the valvae in semicollaris are not parallel as in *figurata*, but rather are basally divergent, therefore giving the valvae a somewhat broadened basal appearance. The two species occur sympatrically over the range where *semicollaris* occurs. As far as is presently known, *figurata* is the more widely spread of the two species.

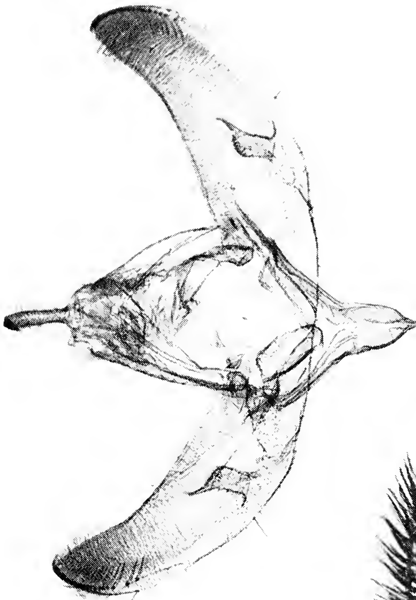
Oncocnemis semicollaris J. B. Smith, 1909. *J. New York Entomol. Soc.* 17 (2):50-61. Barnes and McDunnough, 1917, Check list, p. 56; Draudt, 1923, Macrolepidoptera of the World, 7:184; McDunnough, 1938, *Mem. So. California Acad. Sci.*, 1:80; Rindge, 1955, *Bull. Amer. Mus. Nat. Hist.*, 106 (2):130.

Male: Head with vertex clothed in blackish-brown elongate scales and hairs; frons clothed in brown elongate scales; palpi exterolaterally clothed in brown scales and hairs, basal segment lightest in color; mesally clothed in light brown scales; antennae with scape and pedicle clothed in dark brown scales, flagellomeres dorsally clothed in brown scales, ventrally minutely ciliate. Thorax with collar basally dark brownish-black (this color extending ventrally around compound eyes), thence elongate scales brown, apical portion pure white (however collar appearing bicolor, black and white); tegulae clothed in greyish elongate scales and hairs; ventral surface clothed in dirty whitish elongate, simple hairs; legs with femora and tibiae clothed in brownish and light brownish scales and hairs; foretibial claw slightly bifurcate; tarsi uniformly light brown. Primaries dorsally with ground color greyish to just past transverse posterior line, thence blending into a yellowish-brown; basal line represented costally in black, thence wanting; transverse anterior and transverse posterior lines with median dash as in figs. 2 and 3, black; black dash present, prominent on M_1 from median area to terminal area (see figs. 2 and 3); veins in terminal area lightly outlined in black; fringes brown; ventral surface brown; transverse posterior line costally represented in black thence fading out. Secondaries dorsally a dirty white with sprinkling of brown scales; veins outlined in brown;

2

3

Fig. 2.—*O. semicollaris,* male. Johnsville, Plumas Co., California, 27 July 1964 (H. J. Pini).
Fig. 3.—*O. semicollaris,* female. John Day, Grant Co., Oregon, 29 July 1963 (K. [illegible]).



4

5

Fig. 4.—*O. semicollaris,* male genitalia, minus aedeagus. Salem, Marion Co., Oregon, 28 June 1960, Bauer-Buckett slide no. 69B18-3, (K. Goeden).

Fig. 5.—*O. semicollaris,* aedeagus. Same data as fig. 4.

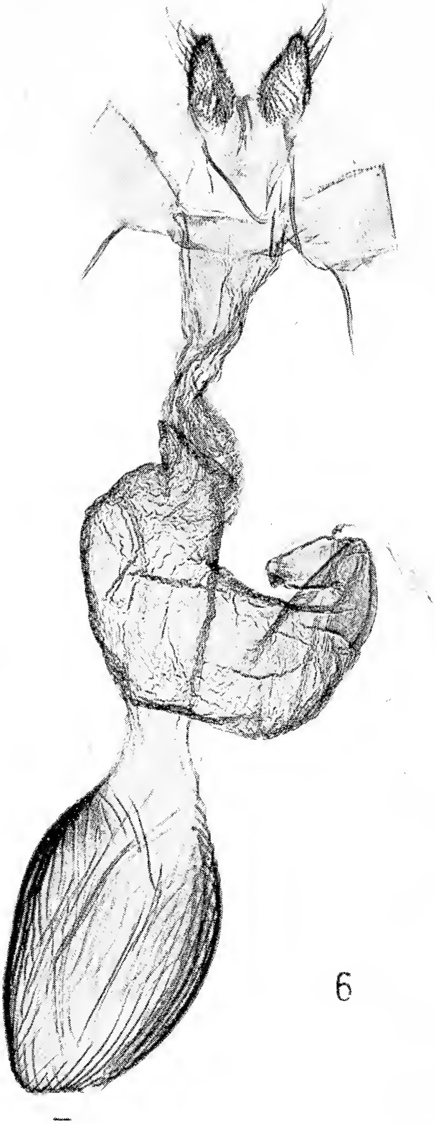


Fig. 6.—*O. semicollaris*, female genitalia. Johnsville, Plumas Co., California,

discal lunule faint, brown; terminal area shaded in brown; fringes basally brown, apically white; ventral surface with ground color as in dorsal surface; discal lunule faint, brown; medial band faint, brown; fringes as in dorsal surface. Abdomen clothed in brownish and whitish scales and hairs. Greatest expanse of forewing 14mm-15mm. Genitalia as in figs. 4 and 5. Female: As in male, except secondaries dorsally brown. Greatest expanse of forewing 14mm-15mm. Genitalia as in fig. 6.

SPECIMENS EXAMINED

British Columbia: Holotype female, Peachland, 8 July 1907 (J. B. Wallis). Oregon: 2 males, Salem, Marion Co., 27-28 June 1960, ex black light trap (K. Goeden); 3 males, Salem, Marion Co., 11 June-9 July 1959, 1960 (Harold Foster); 10 males, Aumsville, Marion Co., June-July 1963-1965 (K. Goeden); 1 male, 1 female, John Day, Grant Co., July, 1962, 1964 (K. Goeden); 1 male, Eugene, Lane Co., 30 June 1961 (K. Goeden); 1 male, Gold Hill, Jackson Co., 2 July 1965 (V. D. Roth). California: 1 male, Hat Creek, Shasta Co., 12 June 1960 (F. W. Stehr); 5 males, 3 females, Johnsville, Plumas Co., June-September 1964-1967 (Helena J. Pini).

I would like to extend my appreciation to those persons who cooperated by providing facilities while at their respective institutions, and especially to Mr. Ken Goeden and to Mrs. Helena Pini for providing the majority of specimens for study.

LITERATURE CITED

BARNES, WM., and J. H. McDUNNOUGH, 1917. Check list of the Lepidoptera of Boreal America. Herald Press, Decatur, Illinois, viii + 392 pp.

DRAUDT, M. (*in* A. A. Seitz), 1923. The Macrolepidoptera of the World. Alfred Kernen Press, Stuttgart, vol. 7, 412 pp. + 96 pls.

McDUNNOUGH, J. H., 1938. Check list of the Lepidoptera of Canada and the United States of America. *Mem. So. California Acad. Sci.* 1:1-272.

RINDGE, F. H., 1955. The type material in the J. B. Smith and G. D. Hulst Collections of Lepidoptera in the American Museum of Natural History. *Bull. Amer. Mus. Nat. Hist.* 106(2):95-172.

SMITH, J. B., 1909. New Species of Noctuidae for 1909. *J. New York Entomol. Soc.* 17(2):57-71.

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distributional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W. J. Reinthal and J. T. Mithell. Send data to Dr. W. J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Proserpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U. S. A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P. O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P. O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W. T. M. Forbes. Entomological Reprint Specialists. P. O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B. M. Endicott. Distributed in U. S. A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P. O. Box 433, New York, N. Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A. I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

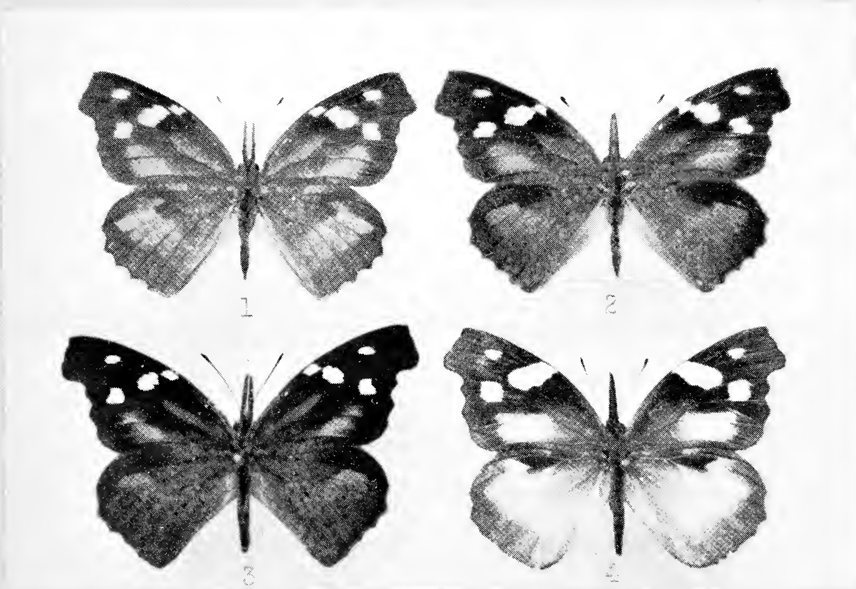
Centurie de Lepidopteres de L'ile De Cuba. P. H. Poey, 1832. C. W. Classey, 353 Hanworth Road, Hampton, Middlesex, U. K. in the U. S. A. Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 10 *Number 3* *September 1971 (1973)*

IN THIS ISSUE

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA



Volume 10 *Number 4* *December, 1971 (1973)*

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

published by

The Lepidoptera Research Foundation, Inc.

at

1160 W. Orange Grove Ave., Arcadia, Calif. U.S.A. 91006

Manuscripts may be sent to the Editor or Associate Editors.

The JOURNAL is sent to all members of the FOUNDATION.

CLASSES OF

MEMBERSHIP

Regular	$ 10	year
Family	15	year
Contributing	25	year
Subscribing	50	year
Sponsor	100	year
Life	250	for life

Subscriptions to the Journal are $12.00 per year. Special subscriptions are available to students at $8.00 per year.

STATEMENT OF OWNERSHIP AND MANAGEMENT

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA is published four times a year, Spring (March), Summer (June), Autumn (September), and Winter (December) by THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The office of the publication and the general business office are located at 1160 W. Orange Grove Ave., Arcadia, California, U.S.A. 91006. The publisher is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. The general editor is William Hovanitz at the above address. The secretary-treasurer is Barbara Jean Hovanitz at the same address. The owner is THE LEPIDOPTERA RESEARCH FOUNDATION, INC. THE LEPIDOPTERA RESEARCH FOUNDATION, INC. is a non-profit organization incorporated under the laws of the State of California in 1965. There are no bond holders, mortgages or other security holders.

Second Class postage paid at Arcadia, California, U.S.A.

Journal of Research on the Lepidoptera 10(4):255-260, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

DIEL EGG-LAYING ACTIVITY OF *AGROTIS EXCLAMATIONIS* (NOCTUIDAE)

IN AN EGG-LAYING RECORDING APPARATUS IN SOUTH SWEDEN

BERT PERSSON

Department of Entomology, Zoological Institute, Lund, Sweden[1]

ABSTRACT

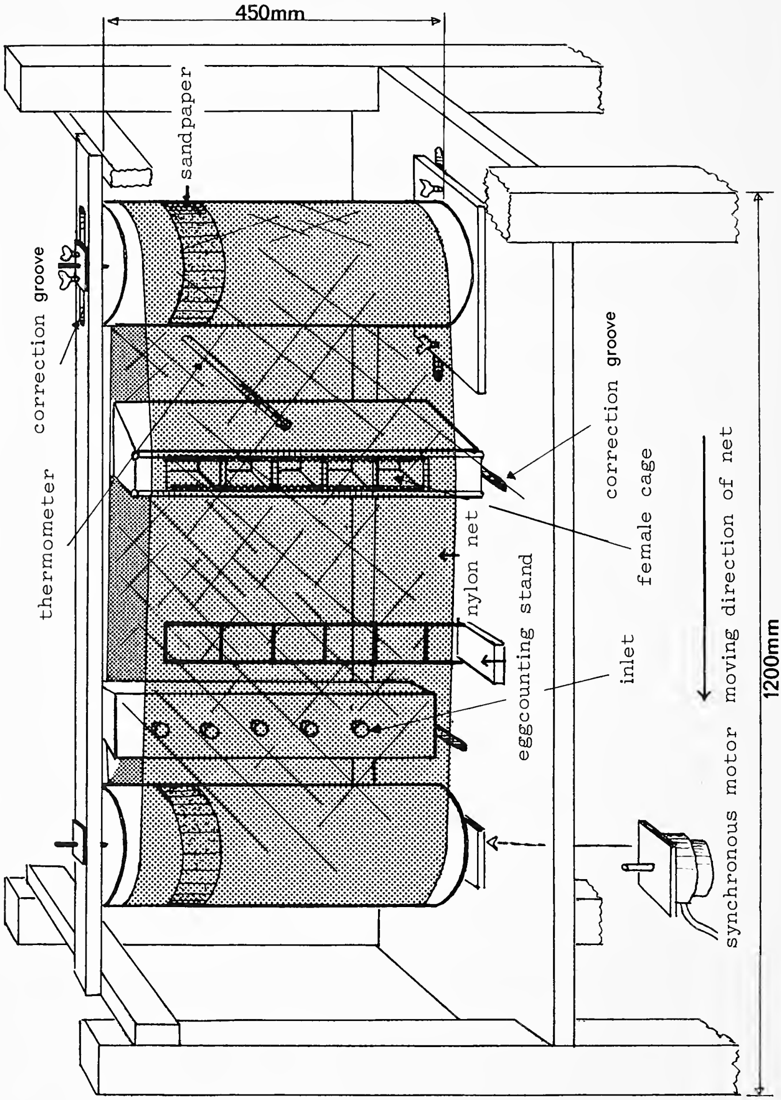
The diel egg-laying activity of some noctuids, mainly *Agrotis exclamationis,* was observed by means of an automatic egg-laying recording apparatus. Most of the females tested laid their eggs in the early part of the night. A second weaker peak in the ovipositional activity was found in the latter part of the night. Around midnight, few females laid eggs.

INTRODUCTION

In connection with light trap experiments performed at Bunkeflo, south of Malmoe (at lat. 55°30′ N. and long. 13°00′ E., Prov. Scania, Sweden) in 1968 and 1969, it was found that the females of noctuids during some summer-months showed a bimodal flight activity (Persson 1971). In order to test if this activity was connected with egg-laying, some observations on the diel ovipositional activity were made in June and July, 1969. On July 1st, sunset and sunrise in the area takes place at 20.51 and 03.30 respectively and the twilight period lasts for 57 minutes.

It had been observed that females kept for flight start observations at Bunkeflo very frequently laid their eggs in the cages rather soon after the twilight period. However, a check of individual females in order to map the diel distribution of egg-laying would be difficult and also too laborious. It seemed obvious that the construction of some kind of automatic recording apparatus was necessary.

[1]Present address: CSIRO Division of Tropical Pastures, Samford, Queensland, 4520, Australia



THE EGGLAYING RECORDING APPARATUS

Sylvén (1958) used such an apparatus in his investigations on fruit leaf tortricids. However, if the diel ovipositional activity of individual females should be observed, only one female at a time could be tested in the apparatus. In order to achieve a sufficient basis for statistical calculations, it was desirable to study several females simultaneously.

At Bunkeflo it was observed that females kept for egg-laying in glass jars almost without exception laid their eggs on the nylon nets covering the jars. They put their ovipositors *through* the nets and attached the eggs to the *outside*. These observations formed the basis for the construction of the egg-laying apparatus.

THE EGG-LAYING RECORDING APPARATUS

The apparatus (Fig. 1) was built on a 1.5 meter high stand. Two 45 cm high drums, one of which was driven by a twenty-four hour synchronous motor, carried a nylon net. One of the drums could be adjusted by two correction grooves in such a manner that the net was always kept stretched. Sandpaper glued to the drums prevented the net from slipping. When the motor was in use, the net was kept moving at a constant speed. Ten females could be tested in the apparatus at the same time. On each side of the apparatus, five females were kept in small cages connected with a stand. Tests on the minimum space necessary for successful egg-laying had been made in advance. The width of the hole in front of the cages was adjusted to correspond to half the distance the net moved in one hour. This arrangement made it possible to count the number of eggs laid per hour. On both sides of the front holes, round polished metal rods were attached in order to make it easy for the net to pass the cages. The two stands with the female cages could be pressed against the net so as to prevent the females from escaping. The pressure could be controlled by means of correction grooves. The females put their ovipositors through the net and laid their eggs on its outside. This was important, because it prevented the eggs from being crushed by the metal rods. Thus as the net passed the holes in the cages, the eggs were laid on it and then followed the moving net away from the cages. The distance between the cages and the drums was such that the first laid eggs did not reach the drums. By means of a movable egg-counting stand the number

Table 1 DIEL OVIPOSITIONAL ACTIVITY

species	Night	22-23	23-24	24-01	01-02	02-03	sum
A.exclamationis	28.6	3					3
A.exclamationis	28.6	42					42
A.exclamationis	28.6	13					13
A.exclamationis	28.6		39				39
A.exclamationis	30.6		5				5
A.exclamationis	1,7	71	143				214
A.exclamationis	1.7	5	63				68
A.exclamationis	1.7				132	51	183
A.exclamationis	1.7	21	87				108
A.segetum	1.7	9					9
P.oleracea	1.7	93	17				110
A.exclamationis	2.7	74					74
A.exclamationis	2.7	67	13				80
A.exclamationis	2.7	134					134
A.exclamationis	2.7	98	47				145
A.exclamationis	2.7		13	9			22
A.exclamationis	2.7		23				23
A.exclamationis	3.7	11	37				48
A.exclamationis	3.7			11			11
A.exclamationis	3.7	27	11				38
A.exclamationis	4.7	58					58
A.exclamationis	4.7		69				69
A.exclamationis	4.7				143		143
A.exclamationis	4.7		16				16
A.segetum	4.7		87				87
R.plecta	4.7				38		38
A.exclamationis	5.7					4	4
A.exclamationis	5.7		40				40
A.exclamationis	5.7		18				18
A.exclamationis	5.7		81	3			84
A.exclamationis	6.7	7	52				59
A.exclamationis	6.7				62		62
A.exclamationis	6.7				4	7	11
A.exclamationis	7.7	47					47
A.exclamationis	7.7	15	41	15	8	9	88
A.exclamationis	7.7			4	11		15
A.exclamationis	7.7				9	14	23
A.exclamationis	7.7		88				88
A.exclamationis	7.7	9	32				41
A.exclamationis	7.7	15	38	6			59
Sum		819	1060	48	407	85	2419
Mean		20.5	26.5	1.2	10.2	2.1	60.5
% of total no. of eggs		33.9	43.8	2.0	16.8	3.5	100
No.of egglaying occasions		20	23	6	8	5	40

Egglaying occasions: Sign. of diff.

2200 - 2300	2300 - 2400	$\chi^2 = 0.56$,	$0.50 > P > 0.30$
2300 - 2400	2400 - 0100	$\chi^2 = 9.96$	$0.01 > P > 0.001$
2200 - 2400	0100 - 0300	$\chi^2 = 16.06$	$P < 0.001$

Fig. 2 TOTAL NUMBER OF EGGS PER HOUR IN THE EGGLAYING RECORDING APPARATUS.

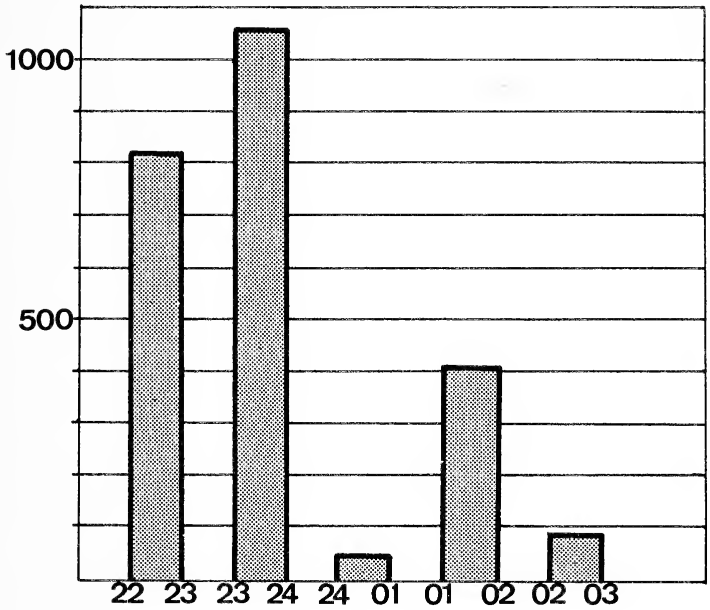
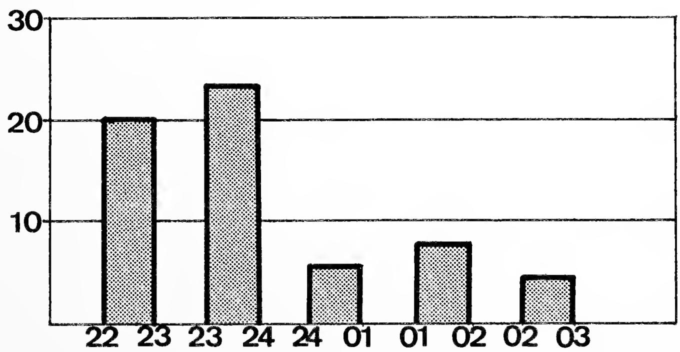


Fig. 3 EGGLAYING OCCASIONS PER HOUR.



of eggs laid by each female per hour could be counted. The eggs were then removed from the net. This task was carried out every morning during the period of observation. The temperature in the cages was controlled from time to time. The stand with the apparatus was covered by a plastic roof, in case of rain, and the construction was intentionally very open in order to allow weather factors (except for rain) to influence the females tested. The apparatus worked both day and night.

RESULTS

Fifty-three females were tested in the egg-laying recording apparatus. Of these, 48 belonged to *Agrotis exclamationis*, the commonest species at the time. 42 females laid eggs but two deposited them in the cages and were disregarded. Altogether over 2400 eggs were laid, the majority in the early part of the night (Table I and Fig. 2). A second but smaller peak in the egg-laying activity occurred between 0100 and 0200, while only few eggs were laid during the darkest part of the night. The number of egg-laying occasions followed the same pattern (Fig. 3), though less pronouncedly so. Only two of the females took longer than two hours to lay their eggs.

REFERENCES

BANERJEE, A. C. and G. C. DECKER, 1966. Studies on the sod webworms. II. Oviposition behavior of *Crambus trisectus* under regullated light conditions in the laboratory. *J. Econ. Entomol.* 59:1237-1244.

CRAWFORD, C. S., 1966. Photoperiod-dependent oviposition rhythm in *Crambus teterrellus* (Lepidoptera: Pyralidae: Crambinae). *Ann. Entomol. Soc. Am.* 59:1285-1288.

PERSSON, B., 1971. Flight activity of Noctuids (Lepidoptera). A Study based on Light Trap Experiments in South Sweden. Ph.D. Thesis, Lund Univ.

PERSSON, B., in press. Influence of Light on Flight Activity of Noctuids (Lepidoptera) in South Sweden. *Ent. Scand.* 2:4 1971.

SYLVÉN, E., 1958. Studies on fruit leaf tortricids (Lepidoptera). *Stat. Växtskyddsanstalts medd.* 11:74.

Journal of Research on the Lepidoptera 10(4):261-264, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

VARIATION OF *UTETHEISA ORNATRIX* (*ARCTIDAE*)
INCLUDING A NEW SPECIES FROM SAINT CROIX, VIRGIN ISLANDS

ROGER W. PEASE, JR.
Department of Biology, Yale Universtity

Samples of utetheisa ornatrix L. from Saint Croix, V. I. differ from collections from Saint Thomas and Puerto Rico in frequency of fully colored forewings and reduced forewing black spotting. The *colored/unpsotted* phenotype was figured as an unnamed aberration by Moeschler (1886a, 1886b fig. 2). However, Cruzan samples collected in April 1962 included so many examples of this type that the population on Saint Croix is certainly distinct.

Four other subspecies of *Utetheisa ornatrix* have been described. The South-Central American form (*U. o. ornatrix* L.) is found from the Mexican border to Argentina and Chile and in the Galapagos Islands and the Lesser Antilles. The North American form (*U. o. bella* L.) occurs in the United States and southern Canada east of the Rocky Mountains, the Bermudas and the Bahamas. The *ornatrix* and *bella populations* overlap in Texas and some of the central United States where *ornatrix* is an occasional immigrant. The Greater Antillean population (*U. o. venusta* Dalman) occurs in Cuba, Hispaniola and Jamaica. The Puerto Rican population (*U. o. stretchii* Butler) is found on the main island of Puerto Rico.

The five characters of wing markings useful in separating the subspecies are the forewing ground color (*red, orange red, red orange, orange/yellow*), distribution of colored pigment on the

Table. 1, Character frequencies in three population samples from Saint Croix, Virgin Islands collected on 24 April 1962. Sample I was a single female from a separate locality taken for breeding stock. Sample II (near Krause Lagoon) contained 26 males and 24 females; sample III (near Krause Lagoon) contained 27 males and 25 females; sample IV (Agricultural Experiment Station Kings Hill) contained 32 males and 29 females. Two specimens in sample II could not be classified for distribution of forewing color.

	II	III	IV	Total
Distribution of Forewing Color				
Sample size n	48	52	74	174
Colored	.958	.923	.932	.937
Streaked	.021	.058	.027	.034
Intermediate	.021	.000	.027	.017
White	.000	.019	.014	.011
Forewing Black Spotting				
Sample size n	50	52	74	176
Spoted	.080	.000	.040	.040
Unspotted	.920	1.000	.960	.960
Hindwing Black Markings				
Sample size n	50	52	74	176
Wide	1.000	1.000	1.000	1.000
Semi	.000	.000	.000	.000
Narrow	.000	.000	.000	.000
Hindwing Ground Color				
Sample size n	50	52	74	176
Red	.000	.000	.000	.000
Pink	.020	.000	.000	.006
Flush	.100	.000	.014	.034
White	.880	1.000	.986	.960

forewing (*colored, streaked, intermediate, white*), forewing black spotting(*spotted, unspotted*), hindwing black markings (*wide, narrow, semi*) and hindwing ground color (*red, pink, flush,* and *white*). A comparative study of variation in the *Utetheisa ornatrix* complex will appear elsewhere (Pease, 1966a).

UTETHEISA ORNATRIX SAINT-CROIXENSIS Pease, Jr., New Subspecies

Male. Forewing ground color *red.* Ground color extends throughout forewing except for black spots surrounded by white (colored). Red ground color replaces the seven rows of black on white spots on the interior of the forewing (unspotted). The rows of spots are interrupted and restricted to the margins of the wing. The hindwing has white ground color with a thick black margins indented by white between M_3 and Cu . A black band joins the anterior margin to the black border (black markings wide). Hindwing appears pink anterior to vein M_1.

Female. Resembles the male except that the hindwing black markings have a cellular bar and dash to the base of the wing.

Population. Frequency of *colored* forewing is distributed about the mean .937. Frequency of *unspotted* forewing is distributed about the mean .960 (table I). Extra black and white spots may appear on the forewing. Hindwing black markings vary in size, and in the female the dash may be missing.

Described from 173 specimens (85 males and 88 females). 102 of these (51 males and 51 females) were collected in open fields in association with *Crotalaria retusa* L. on 24 April 1962 in the vicinity of Krause Lagoon, Saint Croix, Virgin Islands (Samples II and III, Table I). 74 (32 males and 29 females) were collected on the same date in the cultivated collection of *Crotalaria* at the Agricultural Experiment Station, Kings Hill near Christiansted, Saint Croix. The series have been retained intact in the collection of the author.

The typical Cruzan phenotype (*red/colored/unspotted/wide/white*) is found, rarely, on mainland Puerto Rico and the offshore island of Vieques and in the Virgin Islands other than Saint Croix. However, the high frequencies of *colored* forewing and *spotted* forewing are unique to Saint Croix. Other phenotypes occur there. Some Cruzan specimens resemble the common Puerto Rican phenotype (*U. O. stretchii*).

Since the subspecies is a population concept, differences in character frequency govern population distinctness rather than strict uniformity of individuals (Mayr, 1963 p. 348). A population description giving diagnostic population characteristics follows the description of male and female. Since the population is dynamic in time, the data must be referred to the day of collection, 24 April 1962. Other characters may be important either in morphology or at the biochemical level, and since type series once separated seldom find their way together again, all specimens have been kept at a unit. The dedicated field biologist will readily duplicate the samples on a weekend collecting trip to Saint Croix.

The typical *saint-croixensis* phenotype may be considered a combination of the *red/colored* forewing of *venusta* and the *unspotted* forewing and *wide/white* hindwing of *ornatrix.* Laboratory crosses suggest that *U. o. stretchii* and *U. o. saint-croixensis* are of hybrid origin (Pease, 1966b).

ACKNOWLEDGMENTS

The subspecies is dedicated to Miss E. T. B. of Barnard College and Saint Croix, Virgin Islands, another subspecies of hybrid origin.

Travel was supported in part by an NSF travel allowance during the tenure of an NSF pre-doctoral Fellowship at Yale University.

James Bond, head of the Agricultural Experiment Station, Saint Croix permitted sampling in the collection of *Crotalaria* at Kings Hill, Christiansted.

BIBLIOGRAPHY

MAYR, E. 1963. *Animal Species and Evolution.* Harvard University Press, Cambridge, Mass.

MOESCHLER, H. B. 1886a. On the American species of the genus *Utetheisa* Huebner. *Entomologica Americana* 2: 73-76.

__________ 1886b. Beiträge zur Schmetterlings-Fauna von Jamaica. *Abhandlungen herausgegeben von der Senskenbergischen Naturforschen Gesellschaft,* 14 (3): 25-84. 1 pl.

PEASE, JR., R. W. 1966a. Evolution and hybridization in the *Utetheisa ornatrix* complex (Lepidoptera: Arctiidae). I. Inter- and intra-population variation in the *Utetheisa ornatrix* complex and its bearing hybridization. In Process of publication.

__________ 1966b. Evolution and hybridization in the *Utetheisa ornatrix* L. (Lepidoptera: Arctiidae). II. Hybridization as a factor in formation of Caribbean Island populations of *Utetheisa ornatrix.* In process of of publication.

Journal of Research on the Lepidoptera 10(4):265-266, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

TYPE LOCALITY AND HABITAT — *CYNTHIA ANNABELLA*

THOMAS E. DIMOCK

464 Fairfax Avenue, Ventura, California 93003

Field (1971) has designated the type locality of the newly described but well-known West Coast Lady, *Cynthia annabella* Field as the "First valley west of Arroyo Verde Park, Ventura, Ventura County, California." The illustration is of this valley and is taken towards the north-west. Elevations for the valley bottom at center and the hilltop in back are 500 feet and 880 feet respectively.

Most of the specimens used in the type series were reared by the author from larvae collected on *Malva parviflora* L., an imported weed common, especially with wet winters, in the valley bottom. The nearest source of native foodplant for *C. annabella* is found in the next valley to the west, Barlow Canyon, where a mostly dry creek comes to the surface and supports a large stand of *Urtica holosericea* Nutt. This is probably the only foodplant available, excluding ornamentals in the city, after the annual *Malva* has died, and it is also the food source for a *Vanessa atalanta rubria* Fruhs. population.

The hill pictured is but one of many in the area where *C. annabella,* along with *C. cardui* and less commonly *V. a. rubria,* can be found hilltopping throughout the year, most abundantly so in late winter and spring.

LITERATURE CITED

FIELD, WILLIAM D. 1971. Butterflies of the Genus *Vanessa* and of the Resurrected Genera *Bassaris* and *Cynthia* (Lepidoptera: Nymphalidae). Smithsonian Contributions to Zoology, Number 84.

Type locality and habitat: *Cynthia annabella.*

Journal of Research on the Lepidoptera 10(4):267-272, 1972

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

HELICONIUS CYDNO (NYMPHALIDAE) IN VENEZUELA

WITH DESCRIPTIONS FOR TWO NEW SUBSPECIES

JOHN H. MASTERS[1]

P. O. Box 7511, Saint Paul, Minnesota 55119

Of the *Heliconius*, *Heliconius cydno* Doubleday has one of the most limited ranges but also shows some of the strongest geographical variation. It is truly a montane species having its center of distribution in the Andes of Colombia, although ranging northward, through Central America, to extreme southern Mexico, eastward, in the Andes, to extreme western Venezuela, and southward, on the western cordillera, to Ecuador. The high incidence of geographic subspeciation may be partially due to a restricted elevation requirement for its habitat that renders it unable to traverse high ranges or deep valleys.

In spite of the fact that *H. cydno* is quite diverse in its many geographical forms, they are all readily recognized by a relatively unique appearance (only *Heliconius sapho* Drury and *Heliconius hewitsoni* Staudinger have the same color combinations) and by the consistent appearance of two russet brown bars which form a distinct "U" on the ventral hindwing. Nominate *cydno,* from northern Colombia, is characterized by a deep black (iridescent in fresh specimens) ground color, a yellow bar across the forewings and a large white border on the hindwings. All of the subspecies and forms have this same basic pattern of black, yellow and white, but the variation in the scheme is considerable. The yellow bar of the forewing may be absent (as in *gustavi* Staudinger), divided (as in *cydnides* Staudinger), broken into small spots (as in *hermogenes* Hewitson), or white (as in *chioneus* Bates). The white border of the hindwing may be very small (as in *subcydnides* Stau-

[1]Research Associate, Carnegie Museum, Pittsburgh, Pennsylvania.

dinger), very large (as in *alithea* Hewitson), displaced basaly, leaving a wide margin (as in *hahneli* Staudinger), in a basal-costal postion (as in *weymeri* Staudinger), yellow (as in *hermogenes* Hewitson) or absent (as in *perijaensis* new subspecies Masters). In some cases (e.g *temerinda* Hewitson) the yellow and white coloration is simply reversed. *Heliconius cydno* is quite uniform and constant in appearance in many localities, while in others it is quite variable. It is no surprise that there are many more names available than actual valid geographic subspecies; many of the names apply to polychromatic forms.

In so far as is known at present, *Heliconius cydno* has a very limited range in Venezuela where it occurs in the Andes east to Barinas and in the Sierra de Perija. Considering the variability in the species and the many distinct geographic populations in Colombia, it is not surprising to find three distinct geographic populations in Venezuela occupying respectively, the east (Barinas) slope of the Venezuelan Andes, the west (Merida) slope of the Venezuelan Andes, and the Sierra de Perija. The three subspecies are remarkably distinct from each other, yet relative uniform in each locale. With the considerable attention that Staudinger and others gave to *H. cydno* in the early part of this century, distinct unnamed populations are not expected; however, two of these are apparently unnamed, undoubtedly due to the fact that the Sierra de Perija and the east slope of the Venezuelan Andes have not received much entomological attention until recent years.

The following key, based on the maculation of the dorsal wings, may be used to separate the three Venezuelan subspecies of *Heliconius cydno*—from each other and from extra-Venezuelan subspecies.

1a. White or yellow band, bar or row of spots present on dorsal hindwing 2
1b. Dorsal hindwing immaculate (figure 1C); normal to large yellow band on dorsal forewing; apical spots on forewing not normally present .... *H. cydno perijaensis* new ssp.
2a. White band or row of spots present on hindwing 3
2b. Yellow band, bar or row of spots on hindwing .... various non-Venezuelan subspecies
3a. White band, or row of spots, on dorsal hindwing located on outer margin of wing, or if in limbal area, the black border on outer is narrower .... *H. cydno cydno* and other non-Venezuelan ssp.
3b. White band or row of spots on dorsal hindwing located in limbal area with black margin being as wide or wider (figure 1A, 1B) 4
4a. White band of dorsal hindwing broken into distinct triangular shaped spots with black lines along veins quite pronounced (figure 1A); normal or slightly reduced yellow band on dorsal forewing; apical yellow pots on forewing usually present *H. cydno hahneli* Staudinger

4b. White band of dorsal hindwing not broken into distinct triangular shaped spots (figure 1B); normal yellow band on dorsal forewing; apical spots never present on forewing .... *H. cydno barinasensis* new ssp.

Heliconius cydno perijaensis new subspecies

Quite recently the Sierra de Perija, an isolated offshoot of the Andes dividing the Venezuelan state of Zulia from Colombia, has been visited by Venezuelan entomologists, who have brought back, among many other interesting Lepidoptera, a strikingly marked new subspecies of *Heliconius cydno.* This new subspecies, hereby named *perijaensis,* is quite distinct from any other subspecies of *H. cydno* because the dorsal hindwings are completely immaculate of any white or yellow coloration. Otherwise the maculation is indistinguishable from nominate *H. c. cydno* or *H. c. barinasensis.*

The subspecies is only known from El Tucuco, Zulia, Venezuela but may be presumed to occur, at suitable elevations, all along the eastern (Venezuelan) slope of the Sierra de Perija and possibly on the Colombian side of the range as well. Just to the west of the Sierra de Perija is Colombia's Magdelena Valley where *H. cydno hermogenes* Hewitson flies. *Hermogenes,* which has a broken yellow band on the hindwing and the forewing band broken into small yellow spots, is accompanied by a variety of polychromatic forms—none of which resemble *perijaensis.*

Heliconius cydno perijaensis is not common at El Tucuco, which is probably at a lower than optimum elevation for the species. El Tucuco is the site of a Yupi Indian Mission and is at the end of the road. Because of the presence of notoriously unfriendly Motilone Indians in the immediate area, nobody has ventured very far from the Mission in search of Lepidoptera.

HOLOTYPE MALE: forewing length, base to tip, 43 mm; collected at El Tucuco, State of Zulia, Venezuela, undated [probably March 9, 1967] by Albert Gadou. To be deposited in Carnegie Museum, Pittsburgh, Pennsylvania.

I have examined additional specimens of *H. c. perijaensis* in the collections of Harold Skinner and Albert Gadou in La Victoria and Caracas, Venezuela respectively. Other specimens are in the collections of Francisco Romero at Maracay, Yuri Budaracey at Caracas and the Central University of Venezuela at Maracay. A total of about 18 specimens of *H. c. perijaensis* have been taken so far; the holotype male is the only one to have left Venezuela.

Fig. 1.—Representation of dorsal wing patterns of Venezuelan subspecies of *Heliconius cydno*. A = *H. c. hahneli*, B = *H. c. barinasensis*, C = *H. c. perijaensis*. Colors: forewings black and yellow, hindwings black and white. Approximately 1½ natural size.

Heliconius cydno hahneli Staudinger

This subspecies occurs in the state of Merida, on the western slope of the Venezuelan Andes, and (probably) westward into Colombia. The appearance of the white band on the hind-wing is distinct from that of any other Colombian population. In *hahneli,* this band is white and has been displaced from its normal position (as in nominate *cydno*) basally, leaving a wide black margin (at least as wide as the white band itself) between it and the outer margin. The white band is distinguished further by being broken up into small triangular shaped spots (this occurs to some extent in some yellow banded specimens from the Magdalena Valley of Colombia, e.g. *temerinda*). The yellow band of the forewing is similar to that of nominate *cydno,* however in a few specimens it is broken up into smaller spots, although not as strongly as in *hermogenes* from the Magdelena Valley.

Heliconius c. hahneli is quite rare in collections. Emsley (1965) in his study of speciation in *Heliconius* makes no mention of it and, presumably, did not have the opportunity to examine any.

Heliconius cydno barinasensis new subspecies

This subspecies occurs in the state of Barinas, on the eastern slope of the Venezuelan Andes, and, as would be expected, is closely allied to *H. c. hahneli* of the western slope. *Barinasensis* differs from *hahneli* in the following respects: apical spots are never present on the dorsal forewing of *barinasensis* and the yellow forewing band is usually wider; the white band of the dorsal hindwing is fuller and wider and is not broken into triangular shaped spots as in *hahneli. Barinasensis* looks very much like nominate *cydno,* but differs in having the position of the white band of the hind wing in the shifted position of *hahneli.* In nominate *cydno,* a wide, full white band, is positioned almost at the outer margin with only a very narrow black border between it and the edge of the wing.

I have heard of, but have not seen, two aberrant specimens of *H. c. barinasensis* captured by Yuri Budaracey at Barinitas. In these two specimens, which are undoubtedly polychromatic forms, the yellow band of the forewing is replaced by a brown band. This is quite unusual because, even with all of the variability that has been reported for *Heliconius cydno,* none

have been reported with brown bands. In fact the only forms which vary from the basic black, yellow and white color pattern (e.g. *wernickei* Weymer and *emilius* Weymer) are presumed to be interspecific hybrids between *Heliconius cydno* and *Heliconius melpomene* Linnaeus.

Heliconius cydno barinasensis is quite common, at elevations between 1000 and 1500 meters, on the Barinitas to Santo Domingo Road in the state of Barinas.

HOLOTYPE MALE: forewing length, base to tip, 43 mm; collected on the Barinitas to Santo Domingo Road at 1000 meters, in the state of Barinas, Venezuela, 5 February 1968, by J. H. Masters. To be desposited in Carnegie Museum, Pittsburgh, Pennsylvania.

ALLOTYPE FEMALE: forewing length, base to tip, 45 mm; collected on the Barinitas to Santo Domingo Road at 1000 meters, in the state of Barinas, Venezuela, 6 February 1968, by J. H. Masters. To be deposited in Carnegie Museum, Pittsburgh, Pennsylvania.

PARATYPES: 26 males, 12 females, all collected on the Barinitas to Santo Domingo Road, 1000 to 1500 meters, various dates 1964 to 1968, by J. H. Masters, Harold Skinner, Albert Gadou, Yuri Budaracey and K. Negishi. Pairs will be deposited in the American Museum of Natural History, New York, the U.S. National Museum, Washington and the British Museum of Natural History, London. The remainder, for the present time, will remain in the author's private collection.

Other specimens of *H. c. barinasensis* abound in Venezuelan collections (i.e. those of Harold Skinner, La Victoria, Albert Gadou, Caracas, Yuri Budaracey, Caracas, Francisco Romero, Maracay, Edwin Saino, Maracay and the Central University of Venezuela, Maracay) and others are in the collection of Dr. K. Negishi, Tokyo, Japan.

ACKNOWLEDGEMENTS

I am particularly indebted to Albert Gadou of Caracas, who accompanied me on the collecting trip to Barinas when the types of *H. c. barinasensis* were collected and who provided me with the type of *H. c. perijaensis;* and to Harold Skinner, Francisco Romero, Yuri Budaracey and my other good friends in Venezuela who have been helpful in many ways in my study of Venezuelan Lepidoptera.

LITERATURE CITED

EMSLEY, M. G., 1965. Speciation in *Heliconius* (Lep., Nymphalidae): Morphology and Geographic distribution. *Zoology* 50: 191-254.

Journal of Research on the Lepidoptera 10(4):273-283, 1972

1160 W. Orange Grove Ave., Arcadia, California. U.S.A.

RHOPALOCERA COLLECTED AT LIGHT IN TEXAS[1]

ROY O. KENDALL[2] and PERRY A. GLICK
135 Vaughan Place, San Antonio, Texas 78201 U.S.A.; and,
134 Highland Drive, Brownsville, Texas 78520 U.S.A.

INCREASED USE OF INDUCED LIGHT in the collection of nocturnal insects by entomologists has caused a proliferation of literature on diurnals collected at both visible and ultraviolet (UV) light, not only in the United States but in other parts of the world. Diurnal Lepidoptera have been taken at light in the UNITED STATES by Anderson (1960), Bouton (1962), Curtis (1962), Emmel (1962), Heitzman (1965, 1969), Kimball (1965), Mather (1959), Miller (1970), Oliver (1966), Phillips (1961), Thorne (1960), Wilkinson (1966), and Wood (1969); in MEXICO by Bouton (1962), Butler (1964), and Welling (1963); in CENTRAL AMERICA by Welling (1963); in INDIA by Best (1951, 1956), Donahue (1962), and Shull (1963, 1964); in EAST AFRICA by Sevastopulo (1948, 1955, 1958, 1964); and in the MEDITERRANEAN SEA near Pantellari Island by Sevastopulo (1948, 1964).

The purpose of this paper is to bring together recent published records of diurnal Lepidoptera taken at light in the United States and to add sixty-one species, representing 922 examples, from Texas. Except for one example, the additional species were collected by Perry A. Glick of Brownsville, Texas. The exception, a male *Vidius perigenes* found in the incandescent lighted foyer of a cafeteria in Brownsville, was collected by Kendall 9 November 1969 (Table 1).

Light sources at which diurnals have been taken include incandescent (60 and 150 watt vacuum light bulbs, street lights, "powerful lights", lighthouse beacons, door lights, flood lights, kerosene and gasoline type lanterns), fluorescent (15 and 20 watt tubes and lighted commercial signs), and ultraviolet (2

[1]Contribution No. 203, Bureau of Entomology, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville.

[2]Research Associate, Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services.

TABLE 1

RHOPALOCERA TAKEN AT LIGHT IN THE UNITED STATES

HESPERIOIDEA	TEXAS Glick	TEXAS Others	OTHER STATES	USA TOTALS
Calpodes ethlis (Stoll)	6	-	-	6
Lerodea eufala (Edwards)	16	-	-	16
Lerodea dysaules Godman	1	-	-	1
Amblyscirtes nysa Edwards	-	-	1	1
Amblyscirtes celia celia Skinner	16	-	-	16
Euphyes vestris [*metacomet*] (Harris)	-	-	1	1
Ochlodes snowi (Edwards)	-	-	4	4
Atalopedes campestris (Boisduval)	11	-	12	23
Wallengrenia otho curassavica (Snellen)	36	-	1	37
Vidius perigenes (Godman)	-	1	-	1
Polites themistocles (Latreille)	-	-	2	2
Polites vibex praeceps (Scudder)	12	-	-	12
Hylephila phyleus (Drury)	5	-	-	5
Lerema accius (Smith)	53	-	-	53
Nastra julia (H. A. Freeman)	2	-	-	2
Pholisora catullus (Fabricius)	1	-	-	1
Pyrgus communis albescens Plotz	13	-	-	13

watt argon bulbs, 15 and 20 watt blacklight tubes, and 400 watt mercury vapor lamps). Glick utilized traps equipped with 15 watt UV blacklight tubes and others fitted with three 2 watt argon bulbs. Insect response was approximately the same for each type of light source. Glick's traps were located in Cameron and Hidalgo Counties of extreme south Texas, about 40 miles apart. They were operated 11 and 12 hours per day mainly, but not exclusively, from March through November 1960-1965. Rhopalocera were taken each month of the year except January. The greatest number of species (50) and examples (497) were collected in June and July.

Although an exhaustive search of the literature has not been made, there seems to be little evidence that diurnals are attracted to induced light in the same sense that nocturnals are. Possible exceptions are crepuscular species, although no conclusions are drawn. Evidence indicates most diurnals must be disturbed from their resting places before they appear at induced light. Kendall has experienced this many times in his rearing operations when handling freshly emerged Rhopalocera at night in the laboratory. It is almost impossible to place a specimen in a killing jar without some disturbance; consequently, specimens frequently escape. When this happens, some species will spiral to the ceiling and find their way into the overhead light fixture (three 100 watt bulbs). Other species may circle the floor lamp (three 100 watt bulbs), coming to rest on the lamp shade or actually on the bulb, or they may alight on the nearby furniture or floor. Still other examples will not go to the incandescent lights but will seek a shadowed spot in the laboratory where they rest until captured again, or they go to a window the following morning. Occasionally a specimen will alight on the ceiling. In each instance, if not disturbed again, the specimen will remain throughout the night. In certain other species, flight appears to be purely random. This is especially true of lycaenids which usually settle on the floor. Still another observation is that gravid Rhopalocera usually do not respond, as a whole, favorably under artificial light. *Caria ino melicerta* is one exception. Kendall has obtained eggs from this species under incandescent light. It is possible that most crepuscular species would oviposit under induced light.

The chance of getting certain diurnals at light is greatly increased if the light source is placed near their larval foodplants or in their natural habitats, especially during peak flight periods. Kendall observed several examples of *Callophrys miserabilis*

TABLE 1 (cont.)

	TEXAS		OTHER	USA
	Glick	Others	STATES	TOTALS
Pyrgus philetas Edwards	2	-	-	2
Erynnis horatius (Scudder & Burgess)	-	-	1	1
Thorybes bathyllus (Smith)	-	-	4	4
Thorybes pylades (Scudder)	-	-	1	1
Urbanus proteus (Linnaeus)	2	-	-	2
Urbanus procne (Plotz)	9	-	-	9
Epargyreus clarus (Cramer)	-	-	1	1
PAPILIONOIDEA				
Papilio ornythion Boisduval	1	-	-	1
Pieris protodice protodice Boisduval & LeConte	6	-	1	7
Pieris rapae (Linnaeus)	-	-	7	7
Ascia monuste phileta (Fabricius)	3	-	-	3
Colias eurytheme eurytheme Boisduval	1	-	-	1
Phoebis sennae eubule (Linnaeus)	1	-	-	1
Phoebis agarithe maxima (Neumoegen)	1	-	-	1
Kricogonia castalia (Fabricius)[1]	59	-	-	59

[1]Includes 40 examples of form *lyside* (Latreille).

were taken in a trap operated beneath *Parkinsonia aculeata* L. the primary local larval foodplant for *C. miserabilis*.

On two occasions Kendall accompanied Glick on his light trap run. It was observed that one trap was situated beside a clump of *Celtis pallida* Torr. and *Celtis laevigata* Willd. It was therefore not surprising to find frequent examples of *Asterocampa* and *Libytheana* in this trap. *Ministrymon clytie* was collected exclusively in one area. Although its larval foodplant is unknown, the capture of 34 examples at the same location would indicate the foodplant was doubtless nearby and quite specific. The particular spot for this trap was not examined by Kendall but will be soon.

Disturbance of sleeping or resting diurnals may happen in many ways. Natural predators, such as wild and domestic cats, skunks, snakes, owls, and insects, can cause considerable disturbance around a light source. Skunks are frequent visitors at light traps and street lights where they forage on insects. One night about 2:00 a.m. CST, Mrs. Kendall was awakened by a noise outside the bedroom window. Upon investigating with a flashlight she found a small mantid holding a sphinx moth, *Pholus vitis,* which had come to feed on blossoms of cultivated flowers. The moth was unable to free itself and the mantid enjoyed a good meal. It is interesting to note that mantids also feed during the day. While collecting nocturnals around an extremely well lighted (fluorescent and incandescent) gasoline service station in San Antonio, Texas on June 3, 1962, the Kendalls observed a male *Anea andria* fly to a window of the glassed (three sides) service station office. It appeared to have come from Salado Creek wood about one hundred yards away. Typical of its daytime habits, it was frightened by the first movement to catch it. It darted out and over the rooftop into the darkness not to be seen again.

Another source of disturbance to resting diurnals is directly related to light trap operation. Various orders of insects other than Lepidoptera are attracted to UV light. Beetles and large moths often create considerable disturbance by striking vegetation at or near the light source. One night when the Kendalls were operating a 15 watt fluorescent blacklight, without trap, thirty-two male *Ecales imperalis* came to the light. They came in with such force that all were damaged from striking vegetation near the light; many were decapitated. Heavy insects often fall

TABLE 1 (cont.)

	TEXAS		OTHER	USA
	Glick	Others	STATES	TOTALS
Eurema lisa Boisduval & LeConte	30	-	11+	41+
Eurema nise nelphe (R. Felder)	1	-	-	1
Nathalis iole Boisduval	6	-	-	6
Caria ino melicerta Schaus	9	5	-	14
Lasaia sessilis Schaus	1	-	-	1
Calephelis australis (Edwards)	1	-	-	1
Calephelis perditalis (Barnes & McDunnough)	2	-	-	2
Strymon liparops (LeConte)	-	-	1	1
Ministrymon clytie (Edwards)	34	-	-	34
Calycopis beon (Cramer)	33	-	-	33
Calycopis cecrops (Fabricius)	-	-	4	4
Tmolus azia (Hewitson)	1	-	-	1
Callophrys miserabilis (Clench)	5	-	-	5
Strymon melinus franki Field[2]	240	2	3	245
Strymon columella istapa (Reakirt)	6	-	-	6
Brephidium exilis (Boisduval)	1	-	-	1
Hemiargus ceraunus zachaeina (Butler & Druce)	8	-	-	8
Hemiargus isola alce (Edwards)	1	-	-	1

[2]Subspecies *franki*, Texas only.

short of the light, wander around for a time climbing on various vegetation, and eventually resume their journey to the light source. Such activity could easily disturb any resting diurnal.

Of the fifteen species of Hesperioidea taken by Glick, ten (161 examples) are grass feeders in the larval stage. The five non-grass feeders (24 examples) include *Calpodes ethlius* (6), *Pholisora catullus* (1), *Pyrgus communis albescens* (13), *Pyrgus philetas* (2), and *Urbanus proteus* (2). Glick also collected forty-five species of Papilionoidea representing 736 examples. Local larval foodplants are known for all of these except five: *Papilio ornythion* (1), *Ascia monuste phileta* (3), *Lasaia sessilis* (1), *Ministrymon clytie* (34), and *Chlosyne janais* (1). *P. ornythion* was taken in Glick's yard near two grapefruit trees. Citrus is reported to be its larval foodplant. Light traps were operated in close proximity to the known larval foodplants for most collected species.

Nine of the 82 species collected at light in the United States are represented by more than 20 examples each. Additional notes are given for each of these: *Strymon melinus* (245), multivoltine, collected in April (4), May (25), June (129), July (61), August (22), October (2), and December (2); it is widespread and common in south Texas; larvae eat buds, immature fruit, and juvenile leaves of many trees, shrubs, vines, and herbaceous plants. *Libytheana bachmanii* (197), multivoltine, collected in April (2), May (2), June (49), July (16), August (6), September (5), October (98), and November (19); it is abundant, often swarming and migrating by the millions; larvae eat only *Celtis;* in south Texas it seems to prefer *Celtis pallida* which is an abundant shrub throughout the lower Rio Grande Valley area. *Kricogonia castalia* (59), multivoltine, collected in April (1), May (47), June (8), July (1), and August (2); it is abundantly common in south Texas, often swarming and migrating by the millions; it flies only during the hottest and brightest part of the day, a sudden cloud shadow will cause it to seek lodging beneath a leaf; larvae eat *Porlieria angustifolia* (Engelm.) Gray, an abundant shrub in south Texas. *Lerema accius* (53), multivoltine, collected in February (1), May (2), June (6), July (28), and August (16); it is abundant at times along roadsides and the edge of wooded areas in south Texas; larvae feed on many species of broad-bladed grass. *Eurema lisa* (41), multivoltine, collected in May (4), June (11), July (8), August (2), September (12+), October (3), and November (1); it is common in south Texas; larvae feed on a number of low growing Leguminosae. *Wallen-*

TABLE 1 (cont.)

	TEXAS Glick	TEXAS Others	OTHER STATES	USA TOTALS
Everes comyntas (Godart)	-	-	1	1
Celastrina argiolus pseudargiolus (Boisduval & LeConte)	-	-	1	1
Libytheana bachmanii larvata (Strecker)	159	38	-	197
Anaea andria andria Scudder	1	-	-	1
Asterocampa celtis [*celtis*] (Boisduval & LeConte)	-	-	4	4
Asterocampa celtis antonia (Edwards)	2	-	-	2
Asterocampa leilia cocles (Lintner)	1	-	-	1
Asterocampa clyton texana (Skinner)	3	-	-	3
Asterocampa clyton louisa Stallings & Turner	7	-	-	7
Asterocampa clyton [*clyton*] (Boisduval & LeConte)	-	-	4	4
Vanessa atalanta (Linnaeus)	6	-	6	12
Vanessa virginiensis (Drury)	14	-	-	14
Vanessa cardui (Linnaeus)	1	-	1	2
Nymphalis vau-album j-album (Boisduval & LeConte)	-	-	2	2
Polygonia interrogationis (Fabricius)	1	-	2	3
Polygonia comma (Harris)	-	-	2	2
Chlosyne janais (Drury)	1	-	-	1

grenia otho (37), multivoltine, collected in February (1), April (6), June (5), July (3), August (6), September (7), October (6), and November (3); common in the lower Rio Grande Valley of Texas; the case-bearing larvae feed on various grasses. *Callophrys beon* (33), multivoltine, collected in April (1), May (3), June (20), July (5), August (3), and November (1); common throughout south Texas; apparently larvae feed on foliage of several different annuals including *Croton monanthogynus* Michx. on which Kendall has reared it several times. *Phyciodes phaon* (26), multivoltine, collected in June (3), July (16), August (1), and September (6); common over much of Texas but closely associated with its larval foodplant, *Phylia* (formerly known as *Lippia*). *Ministrymon clytie* (34), multivoltine, collected in May (4), June (5), July (6), August (16), September (2), and November (1); fairly common at times in Brownsville, Texas along the edge of wooded areas; larval foodplant unknown, but the insect is most likely closely associated with it.

Perhaps the most significant conclusions which may be drawn from these data are: Diurnal Lepidoptera taken at light is an indicator of species spatial and temporal distribution for a given area. In some instances, one may determine the period of peak emergence or abundance. Captures may indicate light source proximity to specific larval foodplants. Additional research is necessary to identify crepuscular species and determine the significance of this phenomenon.

Tabulated here are 82 species of Rhopalocera representing 1,044 specimens collected at induced light in 14 states. Of the examples taken, 87% was collected in Texas by Perry A. Glick. Temporal distribution shows most examples were collected in July and August (54%), while 11% was taken in May, 13% in August, and 12% in October. Species arrangement follows dos Passos (1964, 1969 & 1970).

ACKNOWLEDGEMENT

We wish to thank Killian Roever for determining some of the species, and for reviewing the manuscript and offering useful suggestions.

REFERENCES CITED

ANDERSON, W. A., 1960. Capture of *Nymphalis j-album in* Maryland at night. *J. Lepid. Soc.* 14:62.

TABLE 1 (cont.)

	TEXAS		OTHER	USA
	Glick	Others	STATES	TOTALS
Chlosyne lacinia adjutrix Scudder	11	-	-	11
Phyciodes tharos tharos (Drury)	17	-	1	18
Phyciodes texana texana (Edwards)	2	-	-	2
Phyciodes phaon (Edwards)	26	-	-	26
Phyciodes vesta (Edwards)	1	-	-	1
Speyeria diana (Cramer)	-	-	1	1
Speyeria cybele cybele (Fabricius)	-	-	3	3
Euptoieta claudia (Cramer)	1	-	-	1
Danaus plexippus plexippus (Linnaeus)	1	-	1	2
Danaus gilippus strigosus (Bates)	2	-	-	2
Lethe portlandia portlandia (Fabricius)	-	-	2	2
Euptychia gemma freemani (Stallings & Turner)	1	-	-	1
Euptychia hermes sosybius (Fabricius)	27	-	-	27
Cercyonis pegala [pegala] (Fabricius)	-	-	2	2
Cercyonis pegala nephele (Kirby)	-	-	1	1
Total Species --------------------------------	60	4	32	82
Total Examples ------------------------------	921	46	89	1,056

BEST, A. E. G., 1951. The butterflies of Bombay and Salsette. *Journ. Bombay nat. hist. soc.* 50:331-339.

————, 1956. Further notes and additions to the list of butterflies from Bombay and Salsette. *Journ. Bombay nat. hist. soc.* 54:215-216.

BOUTON, DAVID W., 1962. Butterflies at lights. *J. Lepid. Soc.* 16:128.

BUTLER, ROBERT B., 1964. A Mexican satyrid at light. *J. Lepid. Soc.* 18:116.

CHAMBERS, D. S., 1963. Evening mating in *Hypaurotis crysalus* (Lycaenidae). *J. Lepid. Soc.* 16:200.

CURTIS, CHRISTOPHER C., and WILLIAM F. BOSCOE, 1962. Butterflies at light in North Carolina and Pennsylvania. *J. Lepid. Soc.* 16:174.

DONAHUE, JULIAN P., 1962. Observations and records of butterflies attracted to light in India. *J. Lepid. Soc.* 16:131-135.

DOS PASSOS, CYRIL F., 1964. A synonymic list of the Nearctic Rhopalocera. *Lepid. Soc. Mem.* 1, 145 pp.

————, 1969. A revised synonymic list of the Nearctic Melitaeina with taxonomic notes (Nymphalidae). *J. Lepid. Soc.* 23:115-125.

————, 1970. A revised synonymic catalog with taxonomic notes on some Nearctic Lycaenidae. *J. Lepid. Soc.* 24:26-38.

EMMEL, THOMAS C., 1962. *Ochlodes snowi* at blacklight in Colorado (Hesperiidae). *J. Lepid Soc.* 16:234.

HEITZMAN, RICHARD, 1965. More observations on the attraction of diurnal lepidoptera at light. *J. Lepid. Soc.* 19:179-180.

————, 1969. Nocturnal copulation of rhopalocera. *J. Lepid. Soc.* 23: 105-106.

HESSEL, J. H., 1965. Multiple capture of *Hypaurotis crysalus* at light. *J. Lepid. Soc.* 19:55-56.

KIMBALL, C P., 1965. Lepidoptera Florida, Anthrop. Fla., 1:40.

MATHER, BRYANT, 1959. *Vanessa atalanta* taken at Atlanta City at 2 A.M. *J. Lepid. Soc.* 13:18.

MILLER, LEE D., 1970. Multiple capture of *Caria ino melicerta* (Riodinidae) at light. *J. Lepid. Soc.* 24:13-15.

OLIVER, CHARLES G., 1966. *Speyeria cybele* (Nymphalidae) at light. *J. Lepid. Soc.* 20:44.

PHILLIPS, LEONARD S., 1961. *Nymphalis j-album* captured at flourescent light in Chicago. *J. Lepid Soc.* 15:101.

SEVASTOPULA, D. G., 1964. Attraction of butterflies at light. *J. Lepid. Soc.* 18:73-74. [Includes species contained in Entomologist: 1948 (81:186), 1955 (88:37) and 1958 (91:86)]

SCHULL, ERNEST M., 1963. The butterflies of south Gujarat. *Journ. Bombay Nat. Hist. Soc.* 60:597.

————, 1964. Butterflies attracted to light in Gujarat State, India. *J. Lepid. Soc.* 18:159-163.

THORNE, ALVIN L., 1960. *Lycaenopsis pseudargiolus* in light trap. *J. Lepid. Soc.* 14:242.

USMAN, S., 1956. Some insects attracted to light. Part III. *Journ. Bombay Nat. Hist. Soc.* 53:482-484.

WELLING, EDUARDO C., 1963. Rhopalocera attracted by ultraviolet light in Central America. *J. Lepid. Soc.* 17:37-38.

WILKINSON, RONALD S., 1966. *Cercyonis pegala nephele* (Satyridae) at flourescent light. *J. Lepid. Soc.* 20:12.

WOOD, J. B., 1969. Swarm of *Eurema lisa* under mercury vapor lamp. *J. Lepid. Soc.* 23:264.

WYNTER-BLYTH, M. A., 1957. Butterflies of the Indian region. xx + 523 pp., 72 pl. (27 col.), p. 123. *Bombay Natural History Society,* Bombay.

1160 W. Orange Grove Ave., Arcadia, California. U.S.A.

NEW BUTTERFLY RECORDS FOR THE UNITED STATES (HESPERIIDAE & LIBYTHEIDAE)[1]

J. RICHARD HEITZMAN[2] and ROBERT L. HEITZMAN
3112 Harris Avenue, Independence, Missouri

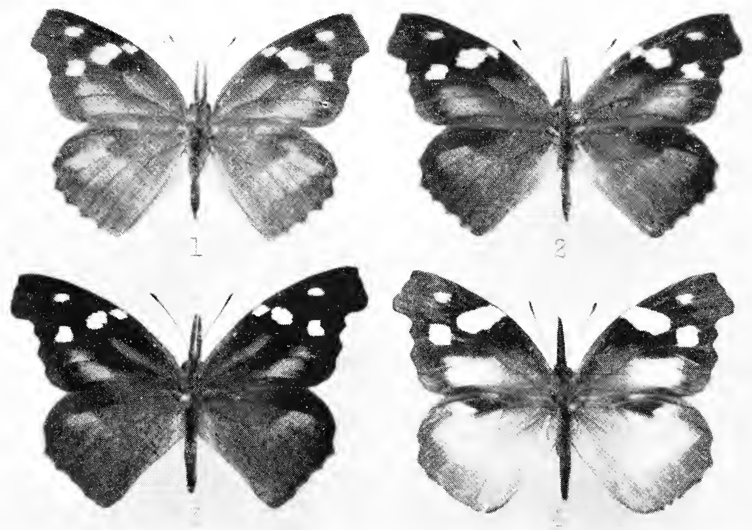
COLLECTING IN SOUTHERN TEXAS during June 1968 produced an abundance of new and unusual species of Lepidoptera, due perhaps to an unusually wet season. One species of Pyrginae new to the United States was collected – *Polythrix mexicanus* Freeman, 1969, a species recently described from Valles, S.L.P., Mexico. This species bears a close resemblance to *Polythrix asine* (Hewitson), 1867. Specimens were collected 28 June in Bentsen Rio Grande Valley State Park in Hidalgo County, where its restricted habitat preferences made collecting difficult. The only specimens collected or observed were found in deeply shaded areas under tropical vegetation. These same areas were producing *Synapte malitiosa pecta* Evans, 1955, and *Monca telata tyrtaeus* (Plotz), 1883. A peculiar characteristic which immediately set *P. mexicanus* apart from other species was the habit of flipping up and resting on the underside of a leaf with the wings spread out flat, a habit shared by some Riodinidae.

By contrast June 1969 was extremely dry. Inland localities were practically barren of Lepidoptera, and collecting was largely limited to areas along irrigation canals or beaches along the Gulf of Mexico. Blooming patches of *Avicennis germinanus* (L) (Blackmangrove) along the beaches east of Brownsville, Texas, were congregating areas for many butterflies. We collected a fairly large series of *Libytheana carinenta mexicana* Michener,

---

[1]Contribution No. 207, Bureau of Entomology, Division of Plant Industry, Florida Department of Agriculture and Consumer Services.

[2]Research Associate, Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville.



Figs. 1-2. Dorsal view, *Libytheana bachmanii larvata* (Strecker).
Fig. 3. Dorsal view, *Libytheana carinenta mexicana* Michener.
Fig. 4. Dorsal view, *Libytheana motya* (Hubner).
All specimens from beach area east of Brownsville, Texas, 27 June 1969.

1943 here which were easily separated from the abundant *Libytheana bachmanii larvata* (Strecker, [1878] by their darker appearance and distinctive flight pattern. Flying here with *larvata* and *mexicana* we collected probably the only U.S. specimens of Libytheana motya (Hubner), [1823]. Two females were taken 27 June by the junior author and at least two additional specimens were subsequently seen but not captured. The specific status of *Libytheana motya* is uncertain. Bates (1935) treated it as the Cuban subspecies of *L. carinenta* (Cramer), [1777]. It is pictured on Pl. 64 of Boisduval & Le Conte's "Lepidopteres . . . de L'Amerique Septentrionale", perhaps from specimens caught or reared by John Abbot in Georgia. It was relegated to the synonymy of *L. bachmanii* by McDunnough (1938) and dropped from the list of Nearctic Rhopalocera by dos Passos (1964) for lack of any known United States records. For the present the question of whether these specimens represent a distinct species or were merely genetic recessives in the mainland populations of *L. carinenta* is unresolved. On the strength of these captures we feel that *Libytheana motya* should be reinstated as a member of the Nearctic Rhopolocera.

We wish to thank Mr. H. A. Freeman of Garland, Texas, for determining *Polythrix mexicanus*: Mr. Oakley Shields, University of California, and Dr. Cyril F. dos Passos, Mendham, N.J., for confirming the *Libytheana motya* determination; and the Texas Parks and Wildlife Department for furnishing us with the necessary state park collecting permits.

LITERATURE CITED

BATES, MARSTON, 1935. The Butterflies of Cuba. *Bull. Mus. Comp. Zool. Harvard College.* 78 (2):65-258.

BOISDUVAL, J. A. & J. E. LE CONTE, 1829-1837. Histoire generale et iconographique des lepidopteres et des Chenilles de L'Amerique Septentrionale. Paris.

DOS PASSOS, C. F., 1964. A synonymic list of the Nearctic Rhopalocera. *Lep. Soc. Mem.* 1.

McDUNNOUGH, J., 1938. Checklist of the Lepidoptera of Canada and the United States of America, Part 1, Macrolepidoptera. *Mem. So. Calif. Acad. Sci.* 1 (1).

Journal of Research on the Lepidoptera 10(4):287-300, 1972

1160 W. Orange Grove Ave., Arcadia, California. U.S.A.

THE DISTRIBUTION OF *PARATRYTONE MELANE* AND ITS SPREAD INTO SAN DIEGO COUNTY (HESPERIIDAE)

J. B. HEPPNER[1]
Department of Entomology
University of California, Berkeley

THIS PAPER IS INTENDED TO SUPPLY LOCALITY DATA on the distribution of *Paratrytone melane* (Edwards) with emphasis on the nominate subspecies in California. No taxonomic studies of the populations involved have been made. The focal point of this study concerns the spread of *P. melane* into San Diego County in 1941, which was sudden and well noted by resident collectors due to its previous absence from the county.

The California distribution is somewhat allopatric with a northern population concentrated in the San Francisco Bay area and a southern population in most of coastal southern California. The spread of *melane* into San Diego County requires further behavioral and ecological studies to be fully elucidated. It is hoped that this paper will stimulate further study of this species.

LIFE HISTORY

William H. Edwards described the species from two specimens he received from "California" and collected by Tryon Reakirt (Edwards, 1869), perhaps in the Los Angeles area where Reakirt did much of his collecting (Essig, 1931). After Edwards' description little was known of the immature stages or the behavior of *melane* until 1930 when Comstock and Dammers worked out its life history. They reared *melane* larvae on Bermuda grass but observed females indiscriminately ovipositing on a variety of cultured lawn grasses (Comstock and Dammers, 1930). What *melane* oviposits on in "natural" habitats is not known but presumably this would include wild grasses, since this is a larval food source typical of the Hesperiidae.

[1]Present address: Dept. of Entomology, Univ. of Florida, Gainesville, Florida 32601.

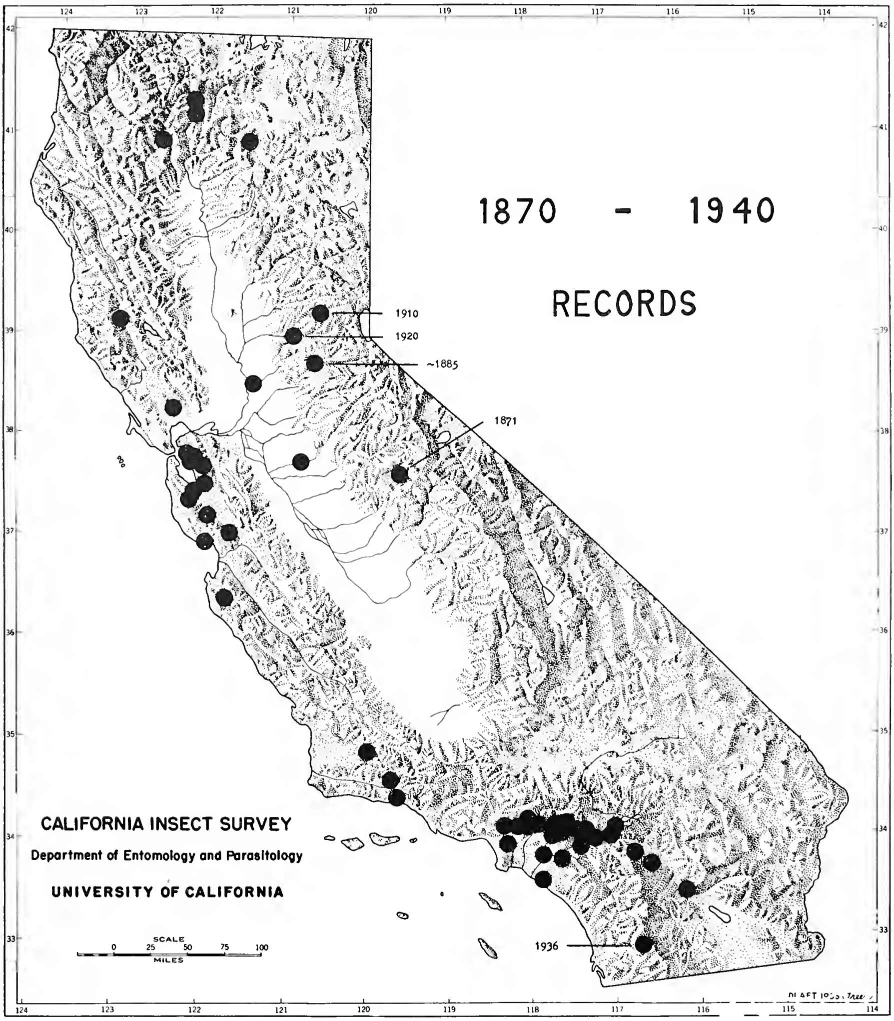


Fig. 1.—1870 to 1940 locality distribution of *P. melane*.

P. melane is at least bivoltine in the northern populations, where it is found from March to June and August to October or even longer in certain localities, and is multivoltine in the southern populations, flying from January to November in San Diego.

Previous to 1930 only cursory mention had been made in the literature to the effect that *melane* was to be found in the coastal foothills of California (Comstock, 1927). Since then the skipper has been caught at elevations varying between almost sea level and in excess of 5,000 feet in the Sierra Nevada Mountains. Typically, *melane* is a resident of the moist, grassy land adjacent to perennial creeks and streams of California foothills encompassing the Upper Sonoran life zone and rarely the Transition life zone. When found in any numbers it is usually in the local *melane* colonies present in the same area year after year.

The behavior of *melane* has been observed by the author to include flight along the edges of streams with occasional pauses to feed on the flowers that are available. This streamside flight is moderate and tends to involve circuitous routes whereby individuals retrace their flight patterns the length of the wooded creek area or in a more restricted flight arena. Although excursions to the peripheral areas of a streamside habitat have been observed, mating behavior or extensive dispersion flights have not been observed.

HISTORY

With many suitable habitats available in San Diego County, it was thought unusual for *melane* to be absent there, yet present only one hundred miles to the north in the Los Angeles area and with no easily defined physical barriers intervening. A list of San Diego County butterflies (Wright, 1930) mentioned *melane* as a possible county resident because of these suitable habitats but there were no records for the county until 1936. The 1936 record ("Mountain area, San Diego County") was not known at the time by resident collectors and is here published for the first time. Prior to 1936 the nearest record to the San Diego area was for Palm Springs (22 Apr 22 - CM) and Indian Wells, Coachella Valley (28 Oct 22 - LACM). The Indian Wells specimen may represent a non-resident individual because of the aridity of the central Coachella Valley (in 1922 there was little irrigation), but the Palm Springs record seems to indicate an established colony, since specimens were collected there

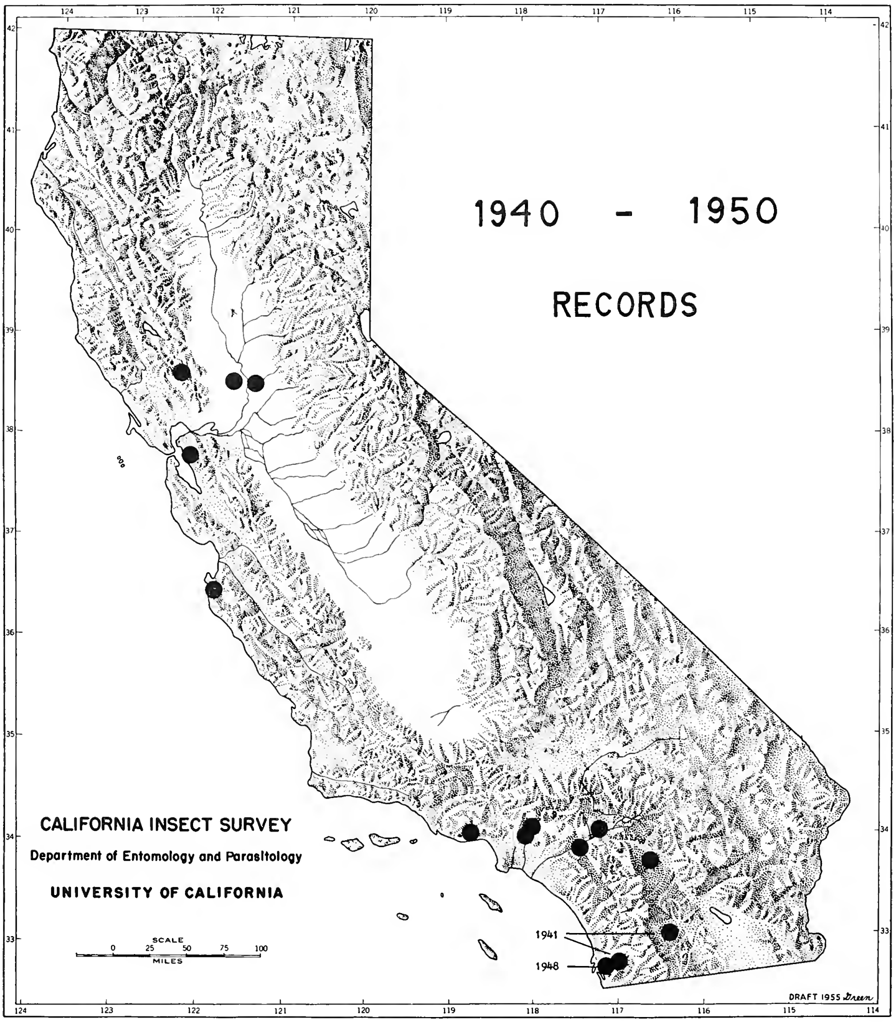


Fig. 2.—1940 to 1950 locality distribution of *P. melane*.

after 1922 and the area does have well-watered canyons as suitable habitats.

August 1941, however, marks the time when resident collectors first encountered *melane* in San Diego County to any extent, regarding it then as a rare capture. F. T. Thorne was one of the first collectors to encounter *melane* and he vividly recounts his excitement upon realizing what was being caught (Thorne, 1963). It might be noted here that lack of adequate collecting in San Diego County should not be considered as substantially contributory to the sudden appearance of the skipper in the county in 1941 because resident collectors were in the field enough to have discovered the species earlier had it been present in any numbers, notwithstanding the 1936 record. Thorne also captured one specimen at the lower end of Mason Valley (= "La Puerta" of old records) in the desert region of San Diego County in October 1941. This site comprises a small area of lush vegetation, high humidity, and year-round running water in a section of Vallecitos Wash.

Since 1941 *melane* has become a well established resident of San Diego County and today it is a common backyard skipper in many parts of the county.

The few individuals who have collected in northern Baja California did not record the species there until 1954 and again in 1958 (Powell, 1958). A very few specimens have been taken in the southern part of the Baja Peninsula (Rindge, 1948) but the remoteness of this population would indicate greater affinities to the Mexican mainland population, as has been mentioned by MacNeill (1962) and Powell (1958). Thus, additional questions arise—Was the northern Baja population present there prior to 1941 or does it represent a southern extension of the San Diego population after 1941? or did the San Diego extension come north from the northern Baja population rather than south from Los Angeles?

DISTRIBUTION

The map series indicates the presence of *P. melane* during the past century in California. From available records the distribution is seen to be discontinuous with the most intriguing gap occurring in the the central coastal area between Big Sur and Santa Barbara. It should be noted, however, that this gap may be due to insufficient collecting, since this area of California is not yet surveyed as well as other areas.

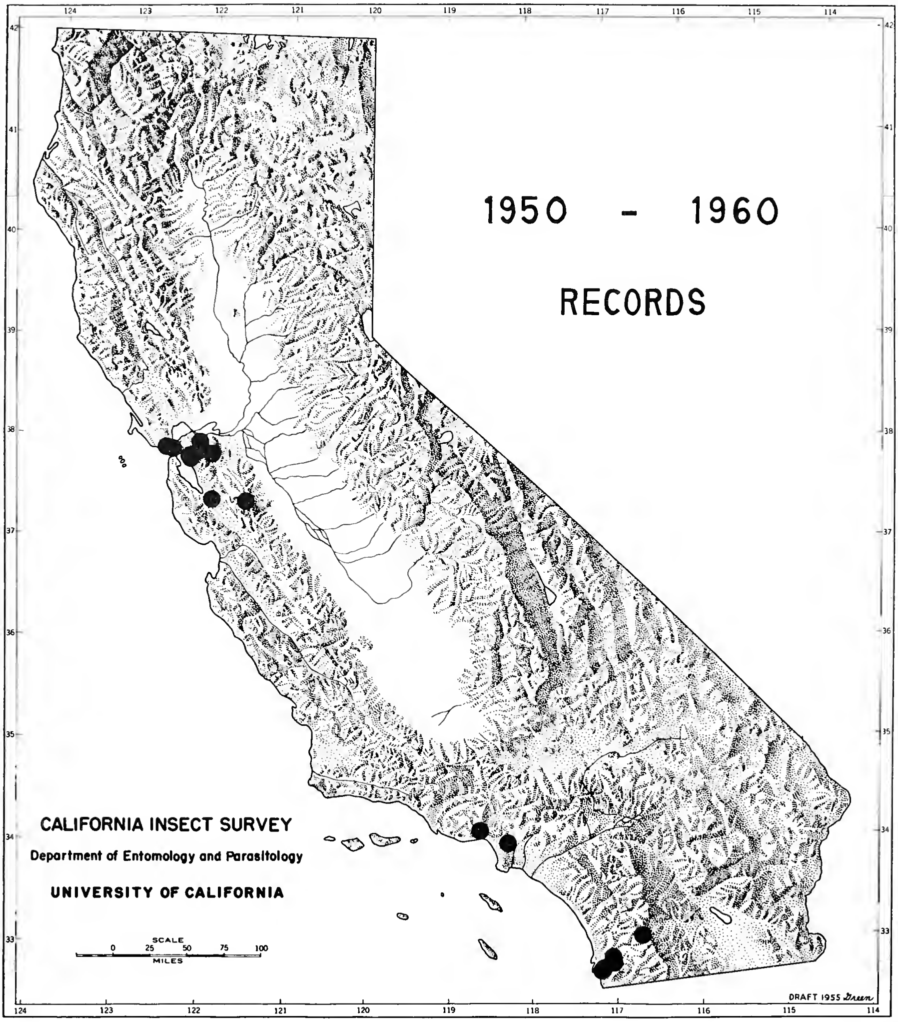


Fig. 3.—1950 to 1960 locality distribution of *P. melane*.

The northern limit in coastal counties is southern Mendocino County, while records further east take these limits to Maxwell, in the Sacramento Valley. The records for Mt. Shasta, Dunsmuir, Trinity Center, and Burney Mountain are interesting owing to their extreme temporal and spatial isolation from the remainder of the known range. Dr. H. K. Clench has remarked (personal communication) that the Oslar specimens, which only the Mt. Shasta specimen is one of, are of dubious value due to evidence that the accuracy of Oslar's specimens is not to be trusted. However, with three other records to date for this general area of northern California Oslar's locality data may be taken at face value for the time being. Whether southern Siskiyou County is to be regarded as the northern limit of *melane* or whether these records represent temporary extensions remains unknown.

Specimens recorded from Prescott, Arizona and "Santa Fe" lack reasonable validity due to their maculation differences from the California populations (Field, personal communication), let alone their extreme isolation, and are not added to the distribution at this time. With further study these latter two specimens may prove to be *P. melane vitellina,* the mexican subspecies.

There are several records for the central Sierra Nevada foothills which may represent a population extension from San Francisco through Sacramento to the Sierran foothills, there being a continuous belt of moist areas for *melane* to progress across the otherwise dry San Joaquin Valley. It is notable in this context that specimens have been recorded from Antioch (in the Sacramento River delta area west of Sacramento), from Davis, from Sacramento proper, and from Sierran foothill localities near Sacramento and further south to Yosemite. Perhaps a study of adult behavior across this "Sacramento bridge" of moist habitats to the Sierran foothills would elucidate mechanisms of spreading that may have functioned in the San Diego area. Additionally, it may be noted that the foothills are not well collected in comparison to higher elevations in the Sierra Nevada. It is not known if the Sierran localities represent resident populations but recent annual captures in the Yosemite area seem to indicate this.

The southern limit is in the Sierra San Pedro Martir of northern Baja California, as far as is known. There being such few records for this area, further collecting may extend the present limit of *P. melane melane.*

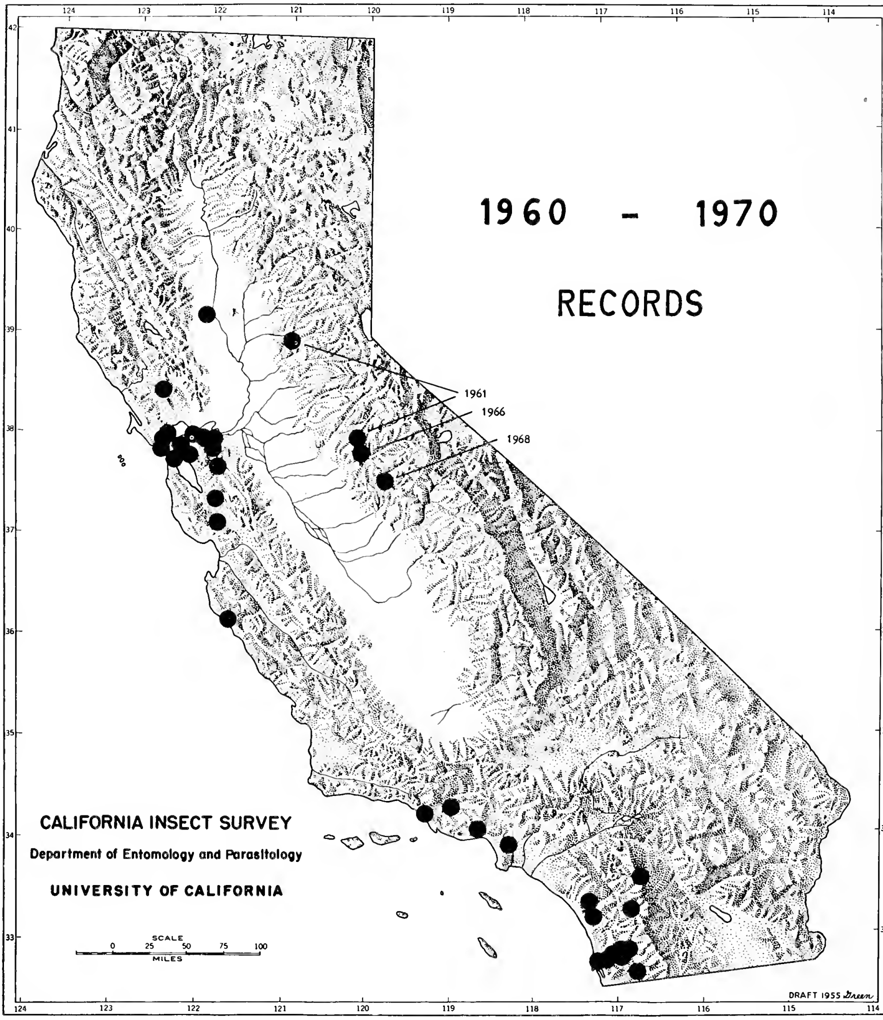


Fig. 4.—1960 to 1970 locality distribution of *P. melane.*

The California populations together with northern Baja California are now considered to comprise the nominate subspecies. The other subspecies are "P. melane ssp." (Rindge, 1948) in the Cape San Lucas region of southern Baja California, *P. melane vitellina* (Herrich-Schaeffer) in central Mexico, and *P. melane poa* Evans in Central America. In his catalog of American hesperiids Evans (1955) distinguished the latter subspecies and also designated *zachaeus* Plötz (formerly considered a subspecies of *P. melane*) as synonymous with *Poanes rolla* Mabille of Surinam. The distribution of all these subspecies is listed below in the interest of including the complete range of the species while detailed data is published for the nominate populations.

CONCLUSIONS

In theorizing on possible pathways for *P. melane* to enter the San Diego area one might conjecture a desert route from Palm Springs to Mason Valley and then to the foothills of San Diego where the 1941 captures were made. While this route may be possible, it is rather arduous because of the 5,000+ foot barrier imposed by the Laguna Mountains between Mason Valley and the coastal foothills.

Another possibility would involve the decreasing rainfall from Los Angeles (ca. 15 inches per year) to San Diego (ca. 10 inches per year) which may represent a factor in the exclusion of *melane* from San Diego County prior to the opening of suitable "island habitats" due to increased irrigation in the years before 1941. In this context additional life history information, such as the extent of breeding on cultured lawn grasses, would be useful in supporting theories of the spread of *melane* by recognizing the impact these new habitats from man's population growth may have had on its spread into San Diego County. Taking into account more recent records for northern San Diego County, individuals may have flown along the coast from breeding areas near Los Angeles by utilizing these "islands" as steps in reaching the available habitats in San Diego foothills where resident colonies could then breed. Whether identical mechanisms have been used (or are now being used) in the central coastal area of California, where suitable habitats also exist, is not known.

From northern records a third theory is possible. *P. melane* may use the moist habitats near rivers as dispersion routes over a period of seasons or with direct dispersion flights. For ex-

ample, records indicate three river systems as possible routes: 1) the delta area to Mariposa County via the San Joaquin and Merced-Tuolumne Rivers; 2) the delta area to Placer County via the Sacramento and American Rivers; and 3) the delta area to Shasta County via the Sacramento River. It is interesting to note that these routes represent linear moist areas leading up to foothill locality records while such linear moist routes are not present between Los Angeles and San Diego because there the streams are all east to west. Of course, irrigation may have provided a new moist north-south route, as has been mentioned.

The question of whether the spread into San Diego County represents a new extension or merely the reclamation of previously occupied territory also remains unanswered. Perhaps, as Thorne (1963) hypothesized, there is a species rivalry in certain localities involving *melane* and the presence of *melane* and other species may fluctuate year by year, even to the extent of local extinction of one species for decades before the area is recolonized: the appearance of *melane* in San Diego County so abruptly in 1941 may represent such a species rivalry.

Much more information on the adult behavior will be required to define methods of increasing the territory of *melane*. The river route theory of dispersion is a case in point because this method would be more plausible if *melane* had the habit of making long flights. If *melane* individuals are more restricted to their breeding areas then dispersion along river systems—and man-made habitats—would be unlikely answers to problems of increasing territory. With the data available at this time, however, it can be concluded that there was indeed a radical increase in territory about the year 1941 and that the subsequent discovery of *melane* in northern Baja California probably represents a further extension to the south from the San Diego population.

ACKNOWLEDGMENTS

Messrs. Keith Hughes and John Lane are kindly thanked for their donation of specimens from Briceburg, Mariposa County and from the Los Angeles area. Their specimens are deposited with the California Insect Survey at the University of California, Berkeley except for one Briceburg specimen which was added to the collection of the California Academy of Sciences. I also wish to thank those individuals who sent the locality records from specimens in their respective institutional or personal collections: Dr. J. P. Donahue (LACM), Dr. F. H.

Rindge (AM), Dr. P. M. Arnaud, Jr. (CAS), Dr. H. K. Clench (CM), Dr. J. G. Franclemont (Cornell Univ.), Dr. L. D. Anderson (UCR), and also special thanks to Mr. F. T. Thorne. I wish to thank Dr. J. T. Doyen (UCB) for helping to develop the "Sacramento bridge" idea. Dr. J. A. Powell (UCB) kindly read the manuscript, assisted in technical problems and also secured the locality data from the U.S. National Museum. The examination of several specimens at the USNM by Dr. W. D. Field is appreciated. Dr. C. D. MacNeill also kindly read the manuscript.

ABBREVIATIONS

AM (American Museum of Natural History); CM (Carnegie Museum); CAS (California Academy of Sciences); CIS (California Insect Survey); LACM (Los Angeles County Museum); UCB (University of California, Berkeley); UCR (University of California, Riverside); USNM (U.S. National Museum). An asterisk indicates that these localities are only considered as part of the distribution on a tentative basis due to their extreme isolation from other populations.

LOCALITY RECORDS

Paratrytone melane melane (Edwards, 1869)
TL: "California"

Calif.: Alameda Co.: Albany, 8 Oct 57 (Powell); Arroyo Hondo, 4 Jul 09 (F.X. Williams); Berkeley, 23 Mar 31, 17 Apr 30, 19 Apr 30 (E.C. Zimmerman), 11 May 65 (E.M. Omi), 18 May 31, 19 May 62 (S. Earnshaw), 7 Sep 57 (Powell), 8 Oct 62 (R.L. Langston); Strawberry Cyn., Berkeley, 16 Apr 50 (Langston), 20 Apr 44, 14 Oct 62 (C.A. Toschi); Irvington, 18 May 02 (Williams); Oakland, 19 Apr 36, 20 Apr 26 (T. Craig), 9 May 08 (Williams), 22 May 55 (B. Hudson); Diamond Cyn., Oakland, 30 Jun 24; Piedmont, 16 Sep 37. Calaveras Co.: Mokelumne Hill, May (F.E. Blaisdell). Colusa Co.: Maxwell, 20 Apr 66 (R.F. Sternitzky). Contra Costa Co.: 2 mi. S. Antioch, 6 Sep 68 (Lane); Briones Hills, 4 May 58 (Opler); Crockett, 30 May 63; Danville, 18 Aug 51 (Williams); Martinez, 1 May 66; 2 mi. S. Moraga, 3 Oct 65 (Langston); Pleasant Hill, 10 May 54, 29 Sep 60 (P.A. Opler); Pt. Molate, Richmond, 22 Sep 66 (Powell); Pt. Richmond, Richmond, 19 May 66 (Langston), 3 Oct 64; San Pablo Resv., 15 May 55 (M.J. McKenney); "Contra Costa Co", 9 May 53. El Dorado Co.: "El Dorado Co" (Koebele collection - CAS) [probably between 1885 and 1887 when Koebele was in California before going to Australia (Essig, 1931)]. Los Angeles Co.: Arroyo Seco, San Gabriel Mts., (2000′), 14 Jun 09 (Grinnell); Long Cyn., San Gabriel Mts., (3000′), 10 Jun 10 (Grinnell); San Gabriel Cyn., San Gabriel Mts., 1 Apr 29 (Gunder); Casa Verdugo, Sep-Oct (H.M. Simms, 1920 - in lit.); Claremont, 14 Apr 26 (T. Craig), 4 May 22; Del Monte, 13 May 44; Palmers Cyn., Claremont, 26 May 21; Dalton Cyn., 20 Apr 28(J. Gunder); Long Beach, 25 Apr (W. Sweadner

collection - CM); Los Angeles, 19 Mar 01, 2 Apr 1899, 4 Apr 20, 5 Apr 1899, 10 Apr 21 (J.A. Comstock), 11 Apr 1899, 28 Apr 1899, 30 Apr 1899, 2 May 27, 11 May 19, 18 May 18, 19 May 03, 10 Jul 57, 24 Jul 61, 7 Aug 59, 20 Aug 61, 17 Sep 16, 23 Sep 16 (Comstock), 14 Oct 53; Griffith Park, Los Angeles, 11 Apr 23, 31 May 20 (Comstock); Monrovia, 21 Jul 28; Monrovia Cyn., Monrovia, 21 May 49; Mt. Wilson ("nr. Pasadena"), 7 Jun 03 (Grinnell, 1905 - in lit.); Oakcrest, 18 Mar 28, 4 Jun 26, 11 Jun 26; Pasadena, 4 Apr 1900 (Bradboid?), 4 Apr 04, 15 Apr 1899, 16 May 04 (Grinnell); Millards Cyn., Pasadena, 21 Mar 26; Pomona, 18 Aug 19 (Lindsey Collection - CM); Temescal Cyn., Santa Monica Mts., 14 Apr 47; Topanga, 22 Feb 61, 17 Apr 59, 30 Apr 60, 5 Aug 55, 25 Aug 55, 30 Aug 55, 7 Sep 56, 9 Sep 56, 14 Sep 57, 19 Sep 60, 8 Oct 58, 8 Oct 62, 9 Oct 57, 23 Oct 57, 27 Oct 57, 29 Oct 55, 27 Nov 58. Marin Co.: Mill Valley, 3 Mar 53 (E.S. Ross); Mt. Tamalpais, 25 May 54 (Powell); Muir Beach, 25 Apr 64; Novato, 19 May 62, 14 Oct 62 (D.C. Rentz); Phoenix Lake, 17 May 62. Mariposa Co.: Briceburg, 5 May 68 (Lane) (Hughes); "Yosemite", 19 Oct 1871 ("S. jr" - T.L. Mead collection - CM); "California", 1871 (James Behrens - ex coll. T.L. Mead - CM: probably the same as from Yosemite). Mendocino Co.: Ukiah, 8 May 19, (Lindsey collection - CM), 17 May 19, 23 May 19, 24 May, 26 May, 8 Aug; "Mendocino Co", 15-23 May (Barnes collection - USNM). Monterey Co.: Carmel, 9 Sep 41, 28 Sep 42 (L.S. Slevin), 30 Sep 41, 18 Oct 40; between Carmel and Paraiso Springs, 22 Oct 39 (Slevin); Partington Cyn., 9 mi. SE. Big Sur, 14 May 66 (Langston). Napa Co.: 2 mi. W. Calistoga, 30 May 49 (C.D. MacNeill). Orange Co.: Costa Mesa (AM); Placentia, 2 Apr 04 (Bradboid). Placer Co.: nr. Applegate, 30 May 61 (MacNeill); Cisco, (ca. 5000′), 1/10 June (AM); Colfax, 10/20 May (AM). Riverside Co.: Indian Wells, 28 Oct 22 (LACM), Mountain Center, 13 Apr 63 (D.E. Bright); Palm Springs, 22 Apr 22 (Coolidge), 1-7 Apr (USNM); Andreas Cyn., Palm Springs, 29 Oct 45 (Timberlake); Riverside, 5 Mar 42, 10 Mar 45 (Timberlake), 24 Mar 40, 14 Sep 28, 15 Oct 33, 1 Nov 28, 18 Nov 28; Santa Ana River (nr?) Chino (S. Bernardino Co.), 16 Apr. 26 (T. Craig). Sacramento Co.: Sacramento, 27 May 18 (E.P. Van Duzee), 12 Aug 47 (MacNeill). San Bernardino Co.: Big Santa Ana Cyn. 26 Mar 21 (LACM); Camp Baldy, 25 Apr 32 (T. Craig), 2 May 32; City Cr., 23 Apr 1892 (Wright); Hanson Dam Park, 15 Mar 61; Loma Linda, 16-23 May, 16-23 Apr (USNM); Mill Cr. Cyn., 21 Sep 23 (Van Duzee); Oak Glen Cr., 17 mi. E. Redlands (5000′), 15 Aug 34 (Timberlake); San Bernardino - no date - (W.H. Edwards collection - CM); Small Cyn., 3 Oct 1886 (Wright); San Antonio Cyn., 15 Oct 31 (T. Craig); Summerland, 11 Jul 47; Upland, 29 Mar 27. San Diego Co.: Barrett Dam, 10 Jul 63 (Langston); El Cajon, 12 Mar 61, 2 Apr 61, 12 Apr 60, 15 Apr 61, 7 May 65; 2½ mi. SE. El Cajon (800′), 4 Feb 67, 15 Feb 63, 18 Apr 62 (all F.T. Thorne); 2 mi. S. El Cajon, 26 Jul 41, 2 Aug 41, 2 Aug 42, 3 Aug 41, 8 Aug 41 (all Thorne); Fallbrook, 2 Apr 61 (E.L. Kessel); 2 mi. NE. Lakeside, 29 Mar 61 (Langston); 7 mi. E. Lakeside (550′), 1 Apr 66, 2 Aug 67 (Heppner); La Mesa, 20 Mar 53 (Williams); Mason Valley, 5 Oct 41 (Thorne); Mission Gorge, 4 mi W. Santee (300′), 28 Mar 72, 26 Jul 65 (Heppner), 24 Aug 52 (Powell); Mission Valley at Hywy 395, 5 mi N. San Diego, 9 Aug 66 (Heppner), Mt. Palomar, 18 Jul 63 (Langston); "Mountain area, San Diego County", 28 Mar 36 (LACM); San Diego, 27 Mar 52, 18 May 52 (Powell); Fairmount Cyn., San Diego, 30 Mar 61, 6 Apr 52, 6 May 52 (Powell), 25 Nov 48 (G.A. Marsh); Presidio Park, San Diego, 15 Feb 52, 18 Oct 52 (Powell); 6 mi. N. San Diego (Morena area) (20′), 12 Apr 70 (Heppner); 1 mi. S. Julian, 5 Oct 58; 2 mi. SE

Vista, 8 May 67 (Thorne); "San Diego Co", 15 Mar 59 (J.C. Ball - UCR). San Francisco Co.: Lobos Cr., Presidio Park, 14 Oct 62 (C.A. Toschi); San Francisco, 12 Apr 61, 14 Apr 61 (R.M. Brown), 19 Apr 60 (P.H. Arnaud). San Mateo Co.: Palo Alto, 11 Sep 12, 22 Sep 05 (Newcomer), 10 Oct 33; 15 Oct 06, 18 Oct 06 (Newcomer); Portola [Valley?], 18 May 07 (Newcomer). Santa Barbara Co.: Paradise Camp, 14 Sep 38 (Rindge); Santa Barbara, 1 Feb 35, 9 Feb 33, 26 Feb 35, 4 Mar 35, 12 Mar 35, 13 Mar 34, 20 Apr, 3 May 35, May 36, (Winters - AM), 3 Jul 34, 4 Sep; Sierra Madre Mts., 19 May 18 (LACM). Santa Clara Co.: Alum Rock Park, 20 Mar 61 (J.W. Tilden), 5 Apr 56 (R.F. Fisher), 12 May 53, 18 May 54, 12 Sep 58; Arroyo Mocho, 12 Jun 55 (Powell); Cherry Flat, 24 Sep 39; Las Uvas Cr., Santa Cruz Mts., 26 Jul 13 (J.C. Huguenin); Los Gatos, Apr 33 (J.A. Kusche); 3 mi. W. New Almaden, 20 Apr 66 (Powell). Santa Cruz Co.: Santa Cruz, 4 May (G.M. Dodge), 11 May 38 (Tilden), 4 Jun (Williams), 1 Sep 39 (Tilden), 2 Sep, 7 Sep 27, 14 Sep, 15 Sep (Williams), 19 Sep 27, 23 Sep 09 (Bradboid?). *Shasta Co.: Burney Mtn., 40 mi. NE. Redding, 5 Jul 30 (E. Guedet). *Siskiyou Co.: Dunsmuir, Jul 34 (G.H. & J.L. Sperry - AM); "Mt. Shasta", June (Oslar, collector; Lindsey collection - CM). Sonoma Co.: Calabazas Cr., nr. Kenwood, 18 May 68 (Emmel); Sonoma, Aug 36; "Sonoma Co", 29 Sep 1898 (H. Engel collection - CM). Stanislaus Co.: Oakdale, 4 Sep 30, 9 Sep 30 (AM). *Trinity Co.: Trinity Center, 1 Jun 25 (AM). Tuolumne Co.: Big Oak Flat at Tuolumne River (1000′), 24 Apr 66 (Lane); 3 mi. NE. Tuolumne, 20 May 61 (R.M. Brown). Ventura Co.: N. of Fillmore, 16 Apr 66 (Lane); mouth of Ventura River, 24 Apr 66 (Langston, Powell, and A. J. Slater), Yolo Co.: Davis, 25 Jun 47, 10 Aug 47 (MacNeill). Misc.: Sulphur Mt. Springs, 30 Mar 18 (LACM); Devil's Cyn., 13 May 30 (C.M. Dammers). [Prescott, Ariz., (B.P. Clark, donor - USNM) - may be *P m. vitellina.* "Santa Fe", Oct 1898 (E.A. Smyth collection - USNM). This may be Santa Fe Springs in Los Angeles County but not Rancho Santa Fe in San Diego County because this name did not arise until 1902 when the Santa Fe Railroad purchased the land in San Diego County. The specimen may also be *P. m. vitellina* from Santa Fe, New Mexico.]

Mexico: 3 mi. S. Encinas, Sierra San Pedro Martir, Baja California Norte, 3 Jun 58 (Powell); 20 mi. E. Descanso, Baja Calif. Norte, 28 Apr 54 (Powell).

"Paratrytone melane — subspecies"

Mexico: La Laguna, Sierra Laguna, Baja California Sur, Oct 1941 (Rindge, 1948).

Paratrytone melane vitellina (Herrich-Schaeffer, 1869)

TL: ?

USA: Texas (MacNeill); Tucson, Ariz. (MacNeill).
Mexico: Los Reyes, D.F., 2 Jul 52 (E.E. Gilbert & C.D. MacNeill - CIS); Durango; Pinal, Puebla; Aguas Caliente, Amecameca; Omilteme, Amula, Xucumantlan, all in Guerrero; Las Vegas; Morelos; Colima; Michoacan; Sinaloa; Chiapas.
El Salvador: (MacNeill).

Paratrytone melane poa Evans, 1955

TL: Mt. Poa, Costa Rica

Guatemala: Volcan de Fuego
Costa Rica: Irazu; Mt. Poa
Panama: Chiriqui

LITERATURE CITED

COMSTOCK, J. A. 1927. Butterflies of California. Los Angeles.

COMSTOCK, J. A. and C. M. DAMMERS. 1930. Notes on the life history of *Poanes melane* Edw. (Lepid.) *Bull. So. Calif. Acad. Sci.,* 29(3): 20-22.

EDWARDS, W. H. 1869. Descriptions of certain species of diurnal lepidoptera found in the United States. *Trans. Amer. Ent. Soc.,* 2: 311-312.

EVANS, W. H. 1955. A catalogue of the American Hesperiidae in the British Museum (Natural History). London, Brit. Mus. (pp. 348-350).

GRINNELL, F., JR. 1905. Butterflies of Mt. Wilson, Southern California. *Ent. News,* 16(5): 134-137.

ESSIG, E. O. 1931. A history of Entomology. N.Y.: Macmillan.

MacNEILL, C. D. 1962. A preliminary report on the Hesperiidae of Baja California (Lepidoptera). *P. Calif. Acad. Sci.,* 30(4th Series)(5): 91-116.

POWELL, J. A. 1958. Additions to the knowledge of the butterfly fauna of Baja California Norte. *Lepid. News,* 12(1-2): 26-32.

RINDGE, F. H. 1948. Contributions toward a knowledge of the insect fauna of lower California. No. 8. Lepidoptera: Rhopalocera. *P. Calif. Acad. Sci.,* 24(4th Series): 289-312.

SIMMS, H. M. 1920. Butterflies observed in Deadhorse Canyon, California, during the 1917 season. *S.W. Sci. Bull.,* 1: 9-12.

THORNE, F. T. 1963. The distribution of an endemic butterfly *Lycaena hermes. J. Res. Lepid.,* 2(2): 143-150.

WRIGHT, W. S. 1930. An annotated list of the butterflies of San Diego County, California. *Trans. San Diego Soc. Nat. Hist.,* 6: 1-40.

1160 W. Orange Grove Ave., Arcadia, California, U.S.A.

HABITAT: *OENEIS MACOUNII* EDWARDS

JOHN H. MASTERS

P. O. Box 7511

Saint Paul, Minnesota 55119

Oeneis macounii occurs in jack-pine forest associations from Alberta to Central Ontario. The photographs (Fig. 1) were taken on a sandy ridge overlooking the Norgate Road in Riding Mountain National Park, Manitoba. These jack-pine association normally occur on sandy or loamy soil that favors the growth of jack pine over other trees. Jack pine (*Pinus banksiana* Lamb.) is always present as an indicator species, although it may comprise only 15-50% of the larger trees in the association. Bracken fern (*Pteridium aquilinum* L.) is very frequent in the substory growth, along with Blueberry (*Vaccinium aquilinum* L.) and Velvet-leaf (*Vaccinium myrtilloides* Michx.). Various species of Sedge (*Carex* species), the probable macounii foodplants, predominate over grasses. The only grass that is consistently found in these associations is Mountain Rice (*Oryzopsis asperifolia* Michx.).

Oeneis macounii has a biennial life-cycle that produces adults once every two years. At this locality, adults can be observed only in odd-numbered years.

Fig. 1.—Habitat: *Oeneis macounii* Edws.

10 VOLUME AUTHOR INDEX

(Vols. 1-10, 1962-1972)

JOURNAL OF RESEARCH ON THE LEPIDOPTERA

NOTICES

WANTED:

Moths of the family Hepialidae in papers or sealed in container with chlorocresol, also larvae and pupae in Bles or similar solution, for distribution study of North American species. Norman E. Tindale, 2314 Harvard Street, Palo Alto, Calif. 94306.

Distributional records and data on habitats and habits for "A biogeographic study of Speyeria diana", by Dr. W.J. Reinthal and J.T. Mithell. Send data to Dr. W.J. Reinthal, 4026 Sequoyah Ave., Knoxville, Tenn. 37919.

Sphingidae of the world. Need particularly Prosperpinus vega and P. desepta and Euproserpinus weisti and E. euterpe from the U.S.A. William E. Sieker, 119 Monona Ave., Madison, Wis. 53703.

Exchanges with lepidopterists. B. de los Santos Garcia. Av. Jose Antonio, 349, 2°, Barcelona-4, SPAIN.

Records of Speyeria zerene hippolyta. Edwin M. Perkins, Div. Biol Sci., University of Southern California, University Park, Los Angeles, Calif. 90007.

LITERATURE RECEIVED:

BIO QUIP PRODUCTS, catalogue of field, laboratory and storage equipment for the natural sciences. Mailing address: P.O. Box 61, Santa Monica, Calif. 90406. Main office ans plant: 316 Washington St., El Segundo, Calif. 90245.

INSECTS, catalogue. Combined Scientific Supplies, P.O. Box 125, Rosemead, Calif. 91770.

De Fennoskandiska och Danska Nattflynas Utbredning (Noctuidae) by F. Nordstrom, S. Kaaber, M. Opheim and O. Sotavalta. Editor, Per Douwes. 1969. Lund, CWK Gleerup.

Lepidoptera of New York and Neighboring States, Part 1. (REPRINT). W.T.M. Forbes. Entomological Reprint Specialists. P.O. Box 77971, Dockweiler Station, Los Angeles, Calif. 90007.

Mariposas de Venezuela, M. Schmid and B.M. Endicott. Distributed in U.S.A. by Entomological Reprint Specialists, address above.

Study Abroad. Unesco. Unipub, Inc. P.O. Box 433, New York, N.Y. 10016.

Writing Research Papers. James D. Lester. Scott, Foresman and Co. Glenview, Illinois 60025.

The Butterflies of the Far East USSR, A.I. Kurentzov (in Russian). Academy of Sciences of the USSR. Siberian Division.

Centurie de Lepidopteres de L'ile De Cuba. P.H. Poey, 1832. C.W. Classey, 353 Hanworth Road, Hampton, Middlesex, U.K. in the U.S.A. Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, Calif.

THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 10 *Number 4* *December, 1971 (1973)*

IN THIS ISSUE